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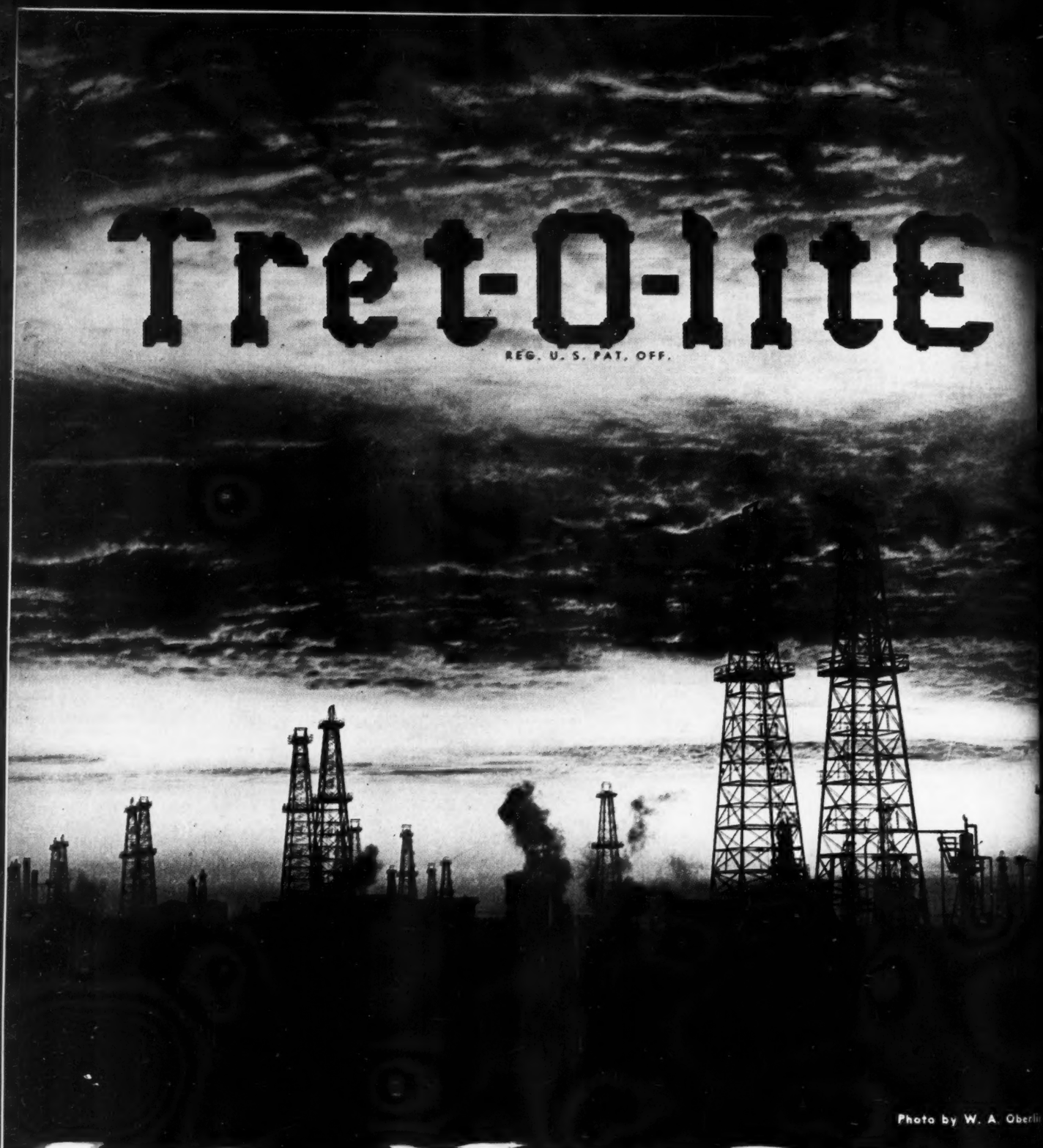

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August, 1941

THE Petroleum Engineer

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(The articles in *The Petroleum Engineer* are indexed in the *Industrial Arts Index*, New York, N. Y.)

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The Course of Oil

by K. C. SCLATER

Bottom-Hole Vs. Reservoir Pressure

In discussing the fallacy of shut-downs in the East Texas field on this page last month, it was stated that "an increase in bottom-hole pressure is not necessarily an indication that the reservoir pressure has increased." One reader, a close student of the subject, apparently unable to reconcile this statement with the rest of the discussion, wrote in to say that, "As all reservoir pressures (in the East Texas field) are based on an average, or weighted average, of bottom-hole pressures, I cannot see how a reservoir pressure could be anything else but a reflection of bottom-hole pressures."

Perhaps the fallacy of shut-downs in the East Texas field will bear further discussion—and clarification.

It should be borne in mind that the weighted average of the bottom-hole pressures taken at selected wells throughout the field is a reflection of the reservoir pressure, but a reflection only and not an accurate measure of reservoir pressure. The actual average reservoir pressure is really higher than the average bottom-hole pressure. Between wells, the pressure in the reservoir sand is greater than that at the well bore—the bottom-hole pressure. If pressure readings could be taken in the reservoir at the points of highest pressure between wells, the weighted average of these throughout the field would be higher than the weighted average bottom-hole pressure.

After a well in the East Texas field goes on production a pressure gradient, or an area of reduced pressure, is gradually formed in the producing sand (the reservoir sand) around the well. Two important factors that govern the pressure gradient are sand permeability and the rate at which the well is produced. Of these, the rate at which the well is produced is the important factor subject to control in the East Texas field. Too great a rate of withdrawal will result in an increase of the pressure gradient around the well. This means that when the field is shut-down the readjustment of reservoir pressure will be greater the greater the rate the field is produced beyond the optimum; but what is the optimum rate of withdrawal for the East Texas field? It is the rate of withdrawal at which the reservoir energy is economically and efficiently utilized.

Reservoir energy in the East Texas field is derived from two sources. The energy of the gas in solution or associated with the oil, and the energy due to hydrostatic pressure of the natural water drive from the west edge of the field.

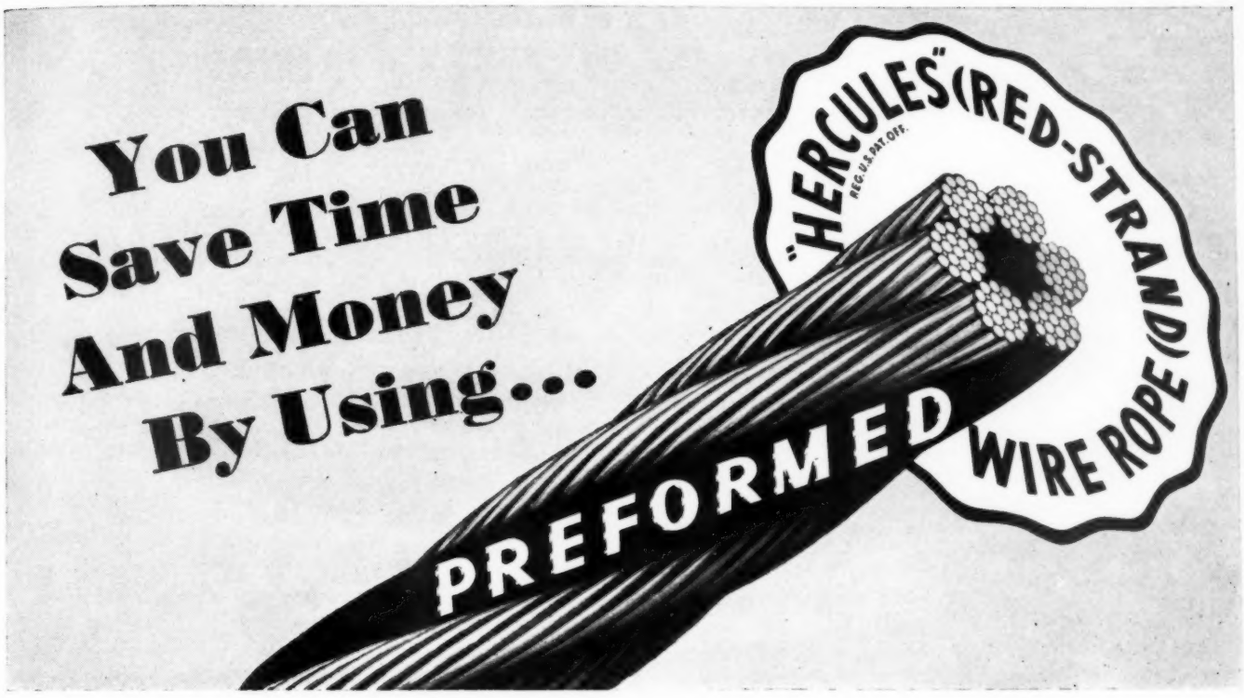
Of these two sources of reservoir energy, that derived from the gas is constantly being depleted as the field is produced. There is no increase of reservoir pressure from this source, even when the field is shut-down. The equalization of reservoir pressure that takes place from this source results only in an increase of bottom-hole pressure, but such increase is not necessarily an increase of reservoir pressure or energy.

Energy derived from the hydrostatic pressure of the natural water drive in the East Texas field is most efficiently utilized when the rate of withdrawal does not exceed the maximum rate at which the water from the west can travel through the reservoir to replace the fluids withdrawn from the reservoir, provided, of course, that such rate of withdrawal is an economical one. Engineering data on the field do indicate that such rate of withdrawal is also the optimum one. If this rate of withdrawal were adhered to, there would be no necessity for shut-downs to "rebuild" reservoir pressure.

Unfortunately, the rate of withdrawal appears to be much greater than the optimum. When the field is shut-down, it gives the lagging water drive an opportunity to "catch-up," with the result that an increase of reservoir pressure takes place. It is well to observe the reason for this increase of reservoir pressure under these conditions. Were the rate of withdrawal the optimum the energy available for producing operations from the natural water drive would be practically constant, and little or no increase in reservoir pressure would result during a shut-down of the field, for there would be no appreciable lag in the water drive and consequently no adjustment of reservoir pressure arising from this source.

It should be reiterated here that when the rate of withdrawal is greater than the optimum, there is danger of water bypassing and trapping oil in the reservoir, and of cutting short the life of many wells on the west edge of the field. Obviously, the fact that the amount of water produced with the oil is constantly increasing, the total rate of withdrawal (of oil, gas, and water) is also thereby augmented. This condition propagates further trouble and eventually may shorten the flowing life of all wells in the field.

The significance of an increase of bottom-hole pressure in the East Texas field during a shut-down is that it reflects an increase of neither reservoir energy nor ultimate production. An appreciable increase of bottom-hole pressure may in large part be the result of a lagging water drive "catching-up", and should be regarded as a danger signal, a warning that the remedy is not a shut-down of the field, but rather a reduction in the rate of withdrawal from the field.



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Highlights IN OILDOM

Illinois' Conservation Bill Becomes Law

Illinois' so-called "stop-gap" oil conservation bill became law on July 28 without the signature of Governor Green. Before leaving on his vacation the governor had listed the oil bill as an "approved-without-signature" measure.

The new law represents a compromise between all interests reached during the closing days of the sixty-second general assembly. It falls far short of Green's desire to establish a three-man oil commission with wide regulatory powers. This failure was a result of various factors in the industry failing to agree on certain features of the program.

The law establishes a formula for spacing of wells, provides for drilling on a block basis in municipalities, establishes safeguards against physical waste, authorizes the division to make provisions concerning drilling, spacing, and plugging of wells, provides a court of review for actions by the division, requires a permit for drilling wells with a $10 fee and $1000 bond to insure plugging, or, in lieu of the latter, proof of financial responsibility.

Prior to the bill having become law Attorney General George F. Barrett had declared the measure unconstitutional, stating it was so full of constitutional flaws that it would be inoperative.

Petroleum Coördinator Harold L. Ickes termed the legislation a "joke", adding that "it is not a conservation bill at all—it should be called A Bill to Encourage Waste of the Resources and Mineral Wealth of the State of Illinois."

Drilling Employees Win Ruling

Employees engaged in the drilling of oil wells, regardless of whether they are employed by the owner of the property or by an independent operator, and regardless of whether they perform the complete drilling operation or only a part, are subject to the wage-hour law. This ruling has been made by Federal Judge James C. Wilson in a suit in the Federal District Court for the Northern District of Texas, Amarillo Division. The case, styled O. V. Hall et al. vs. Warren-Bradshaw Drilling Company, was a suit for overtime pay under the wage-hour law. Judge Wilson awarded the employees $4200, in addition to an attorney's fee of $500.

The plaintiffs were members of a rotary drilling crew drilling oil wells in the Panhandle area of Texas. After their work was finished, a cable-tool crew completed the wells. Judge Wilson held that the plaintiffs were covered by the wage-hour law, despite the fact that they did not complete the drilling of a well, because their work was necessary to the production of goods for interstate commerce.

Judge Wilson, in giving his decision, said that so far as the applicability of the wage-hour law is concerned in this case, it is impossible to distinguish between a contractor performing the work and the owner of the lease himself performing the work. He stated that it is the character of the work done by the employee that determines whether he comes under the terms of the act rather than the character of the business in which the employer is engaged.

The Warren-Bradshaw Drilling Company is appealing the decision to the Federal Circuit Court.

Pennsylvania Joins Compact

The Pennsylvania Legislature on July 17 approved the bill, providing for that state's entrance into the Interstate Oil Compact Commission. Governor James signed the bill on July 23.

New York State approved a bill last April providing for its entrance into the Interstate Compact contingent upon Pennsylvania joining the body.

Seek Oil in "Uncontrolled" New Guinea

Oil search operations in New Guinea will be personally investigated by Allan McDonald, Australian minister for external affairs. Large areas of New Guinea, which is an Australian mandated territory, have scarcely been explored and are occupied by uncivilized natives some of whom are head hunters.

McDonald said the government is determined to assure peaceful penetration of the remote areas. Control of oil search expeditions is made necessary to avoid antagonizing natives and endangering the lives of later prospectors.

Cole Bill Passes

On July 31 President Roosevelt signed the Cole Bill, which previously had been passed by both branches of Congress, giving the administration authority to construct a network of pipe lines. The law is designed to permit transportation of petroleum into the industrial East where, due to a shortage of tankers, a serious lack of oil and gasoline is threatened.

Ask Compact Ratification

President Roosevelt has been asked by oilmen and congressional leaders to transmit for congressional ratification the new Interstate Oil Compact, signed by 11 states and extending for two years from September 1. The present compact agreement expires on September 1.

States that have signed the new compact agreement are Arkansas, Louisiana, New York, Pennsylvania, Oklahoma, Texas, Kansas, Colorado, New Mexico, Illinois, and Michigan. These 11 states produce approximately 74 percent of the nation's crude oil.

Potential Test Order Postponed

Because a previous order is now involved in litigation, the Texas Railroad Commission has postponed indefinitely potential tests for the McElroy field of Crane and Upton counties. The commission has appealed a decision in which Gulf Oil Corporation is interested affecting the allowables in the McElroy field.

Priorities for the Oil Industry

A coördinated program has been developed for assisting the petroleum industry in obtaining priority or preference ratings on essential material and equipment. The program has been worked out by the OPM, OPACS, and the Petroleum Coördinator, and apparently is designed to avoid conflict between the defense agencies in dealing with the problem of supplying the petroleum industry.

Those in the oil industry needing priority assistance henceforth will apply to Harold L. Ickes, Petroleum Coördinator, who will make recommendations to the OPACS and OPM.

MAJOR *Refining* ACTIVITIES

Percent Refining Capacity Operated

Western Division, 70.5 Percent Central Division, 74.8 Percent Eastern Division, 89.4 Percent

PETROLEUM SPECIALTIES, Inc., recently signed a license agreement with Universal Oil Products Company and has modernized its refinery at Flat Rock, Michigan, in order to take advantage of the latest improvements in the Dubbs cracking process.

The plant is running 2350 bbl. per day of Illinois crude oil at present and is cracking about 600 bbl. per day of topped crude oil. With proposed improvements completed, the Dubbs cracking capacity will be increased to 900 bbl. per day.

Built several years ago by the Interlakes Refining Company to operate on Michigan crude oil, the plant until recently has been shut down.

The Francitas Gas Company, Houston, Texas, cycling plant being built in the Francitas field of Jackson County, South Texas, to process gas from leases on holdings largely of The Texas Company, Skelly Oil Company, and British American Oil Producing Company, is progressing rapidly. According to a report from Emby Kaye, head of the Distillate Engineering and Processes Company, Tulsa, Oklahoma, work is continuing rapidly in spite of the difficulty in obtaining specialties used in plants of this type due to national defense. Equipment used in construction of the plant is that of Distillate Engineering and is used under license. Construction of the plant is being done by H. B. Zachry Construction Company. Operation of the plant is expected to begin the latter part of this month.

According to Dan Long, superintendent of the Opelika cycling plant of the Lone Star Gas Company and Shamrock Oil and Gas Corporation, the plant will salvage butane gas that has been going to waste. Installation of the equipment to recover the butane gas is now underway.

At present the plant handles 4500 bbl. of distillate per day and is sending it by pipe line to the Gulf Refining Company's station at Big Sandy, Texas.

Shell Oil Company, Inc., will build a $200,000 cycling plant at Chapel Hill in Smith County, East Texas, to handle gas from the Paluxy zone. The plant is to be constructed to process 25,000,000 cu. ft. per day. Unitizing of the acreage in the area has been underway by Shell, Sun Oil Company, and Hunt Oil Company. At present there are two wells completed in the Paluxy zone in the field.

A plant costing approximately $1,000,000 and having a capacity of 3500 bbl. of crude oil per day is planned by The McColl-Frontenac Oil Company, Ltd., of Canada. The refinery is scheduled for construction on a 60-acre site purchased in the Bonnybrook district in East Calgary, officials announced. Crude oil for the plant will be supplied from the Turner Valley and other oil fields adjacent to Calgary.

James W. Vaiden, vice-president of Skelly Oil Company, in charge of manufacturing, has announced that the present gasoline plant in N½ SW of 27-22-37e, Lea County, New Mexico, is to be enlarged to process 20,000,000 cu. ft. per day of gas.

New equipment to be added to the plant will take gas from the numerous wells of the county, now possessing a hydrogen sulphide content of 277 grams per M. cu. ft. and reduce the content to 15 grams per M. cu. ft.

The treated gas will then be delivered to a carbon black plant to be constructed by the Columbia Carbon Company in 22-22-37e where preliminary tests have revealed that about 1 lb. of carbon black per 1000 cu. ft. of gas will be obtained.

Construction is nearing completion on Shell Oil Company's second toluene plant at Houston, Texas, according to a statement issued by R. G. A. van der Woude, president. The plant is scheduled to begin operation about October 1.

Contract for construction of the plant is held by C. F. Braun Company.

Combined capacity of the two plants will be about 4,000,000 gal. of toluene per year, from which about 40,000,000 lb. of TNT can be manufactured.

Deming, New Mexico, has been selected for the site of a 2000-bbl. refinery, according to Mac Hall, formerly associated with Midwest Refining Company at Artesia, New Mexico. Equipment has been purchased and construction of the plant will begin soon. Eddy County crude oil will be processed and the finished products marketed in the southwest portion of the state and in Arizona. Gasoline, kerosine, distillate, Diesel fuels, and fuel oils will be produced.

Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks
Week Ended August 2, 1941
A.P.I. Figures

(Figures in thousands of bbl. of 42 gal. each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks	Total Gas and Fuel Oil Stocks
East Coast	100.0	593	88.1	21,438	23,058
Appalachian	83.8	137	98.6	3,091	966
Ind., Ill., Ky.	84.4	602	94.8	16,067	8,241
Okla., Kans., Mo.	80.7	315	94.6	6,815	3,783
Inland Texas	63.2	124	74.7	2,058	1,689
Texas Gulf	91.0	937	93.8	12,062	14,343
Louisiana Gulf	89.1	152	108.6	3,157	3,320
No. La. and Ark.	49.9	51	108.5	431	751
Rocky Mountain	50.1	50	73.5	1,279	604
California	90.9	544	76.1	14,416	77,053
Reported	86.3	3,505	89.5	80,814	134,808
Estimated Unreported	.....	340	.....	5,965	2,425
*EST'D TOTAL U. S. AUG. 2, 1941	.....	3,845	.....	(a) 86,779	136,233
*EST'D TOTAL U. S. JULY 26, 1941	.....	3,920	.....	86,945	134,052
U. S. B. of M. *AUGUST 2, 1940	.....	**3,485	.....	88,892	145,859

*Estimated Bureau of Mines' basis.
**July-August, 1940, daily average.
(a) Finished, 79,051,000 bbl.; unfinished, 7,728,000 bbl.

MAJOR *Oil Field* ACTIVITIES

HELMERICH and Payne, Inc. and Phillips Petroleum Company apparently have opened a new field in Norton County, Kansas. Their Cooley No. 1, CSL SE NE, 11-4-21, swabbed 65 bbl. of crude oil of 36-gravity grade in 19 hr. from the Lansing zone before being treated with acid. The well, drilled to 3750 ft., topped the Lansing at 3402 ft., the Arbuckle at 3655 ft., the Granite at 3746 ft. It was plugged-back to 3404 ft. for acidizing.

Hilliard No. 1, C S½, SE SW 27-1n-6e, seven miles south of the Flora pool and about the same distance west of the Cisne pool opens a new field in Wayne County, Illinois. The well drilled by Wiser Oil Company flowed 1183 bbl. of oil in 11 hr. after being drilled to a total depth of 3085 ft. and perforated between 2992-96 ft. and 3021-24 ft. opposite the McClosky lime. The Texas Company No. 1 Leathers, a quarter of a mile from the Wiser well, flowed approximately 400 bbl. per hr. from the McClosky lime at 3015 ft. It is the largest producer in the formation in the Sucker state.

Thirty miles west of Hobbs, New Mexico, and four miles from nearest production a new oil pool has been opened in Lea County, in the southeastern part of the state. The well is State No. 1 and was brought in at a depth of 3098 ft. by Harry Leonard of Roswell and Van S. Welsh of Artesia, New Mexico, independent producers. Ten bbl. of crude oil per day flowed naturally from the well. Production was from the Dolomite structure, which is similar to that in the Lynch field.

Gulf Refining Company's Calcasieu National Bank No. 1, Hayes area, Calcasieu Parish, Louisiana, is credited with being the discovery well of a new distillate field for that state. The well blew out and caught fire during perforating of casing at 10,527-29 ft. Large volumes of gas and distillate were recovered from the well before the blowout. During the blowout the well flowed between 100,000,000 and 200,000,000 cu. ft. of gas and distillate per day before cratering at the end of the casing string at 10,500 ft.

McAlester Fuel Company's Franks No. 1 in 16-18-21, four miles east of the Dorcheat field near Macedonia, opened production as the seventh lime discovery in Columbia County, Arkansas. A distillate well, production was brought in at 8906-14 ft. with 21 shots and after washing flowed 48 bbl. of clear distillate in 3½ hr. through a ¼-in. choke.

Posey County, Indiana, has a new oil field as the result of the Cherry and Kidd Ford No. 1, in 34-40-13w. Drilled to 2976 ft. the well was acidized in the McClosky lime and swabbed 20 bbl. of oil without water in 12 hr.

Southwest Texas areas have a new pool opened by Adams No. 1, about one and a half miles west of the Alfred pool in Jim Wells County. The well is owned by Wilcox Oil and Gas Company and Ike Howeth, and was drilled by Fallis and Wise. Perforations at 4312-22 ft. showed 5 bbl. of fluid per hr. through ⅛-in. choke with 1080-lb. casing and 200-lb. tubing pressure. A squeeze job was necessary when salt water intrusion interrupted flow.

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New Mexico	.70-1.15
Texas	
North Central	.68-1.27
Panhandle	.70-1.15
West Texas	.70-1.12
Gulf Coast	.95-1.48
Darst Creek	1.14
East Texas	1.27
Talco	.79
Kansas	.70-1.25
Oklahoma	.70-1.25
Arkansas	.68-1.30
Louisiana	
Rodessa	.88-1.20
Gulf Coast	.95-1.48
North Louisiana	1.20-1.30
Illinois	1.22-1.37
Kentucky	1.32-1.43
Indiana	1.22
Ohio	
Lima	1.05
Michigan	1.24-1.44
Pennsylvania	
Bradford	2.75
Southwest	2.40
Eureka	2.34
Buckeye	2.30
Corning	1.31

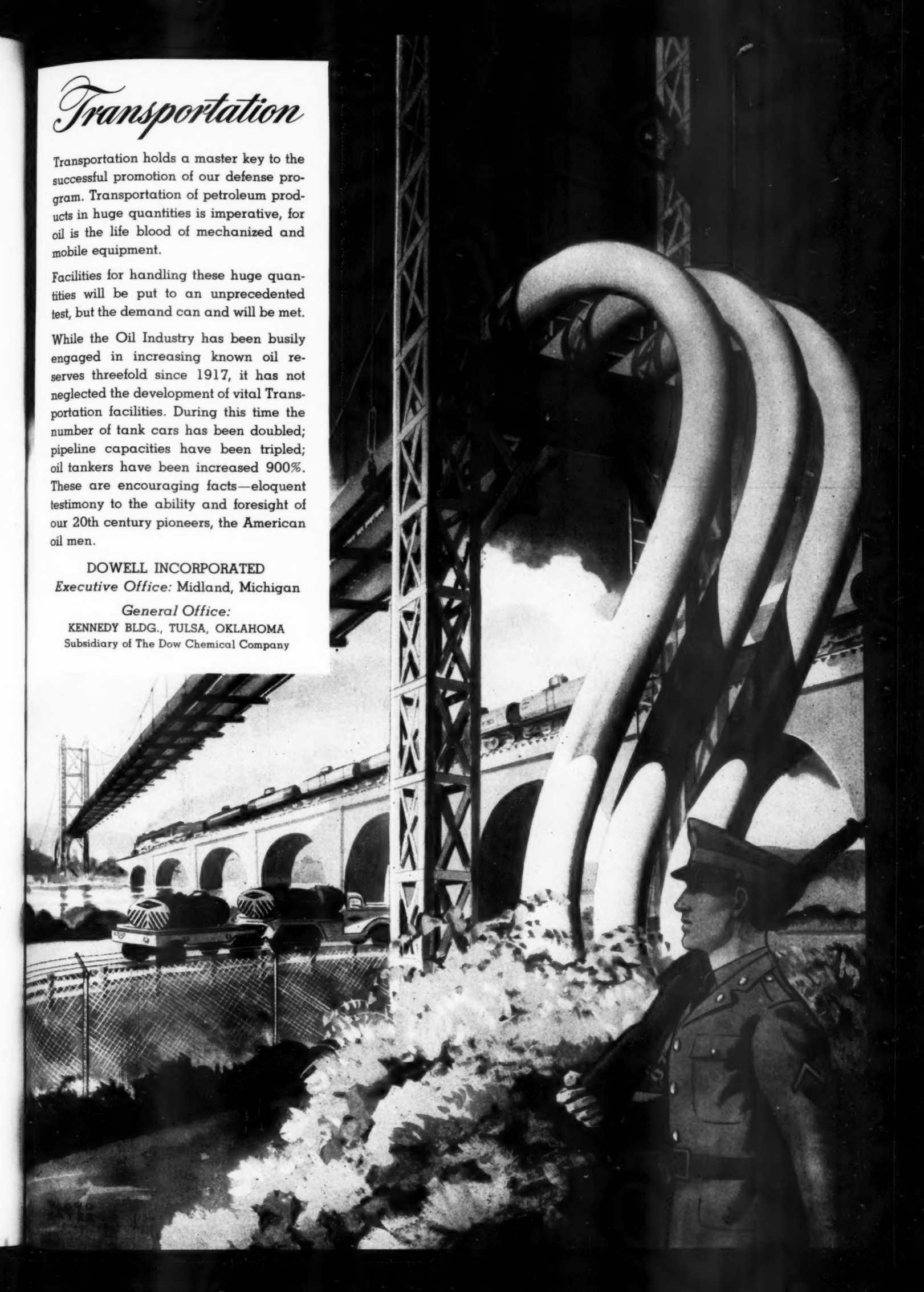
DAILY AVERAGE CRUDE OIL PRODUCTION
Data Supplied by A.P.I.

(Figures in bbl. of 42 gals. each)

	[1]B. of M. Calculated Requirements (July)	Week Ended Aug. 2, 1941	Week Ended June 28, 1941	Week Ended Aug. 3, 1940
Oklahoma	498,500	[2]417,050	420,850	410,000
Kansas	225,300	[2]235,500	237,300	183,150
Nebraska	4,200	[2] 5,050	4,750	150
Panhandle Texas		80,750	82,450	66,000
North Texas		99,900	102,200	84,750
West Central Texas		29,650	30,850	28,250
West Texas		221,650	264,050	182,600
East Central Texas		79,400	80,600	72,950
East Texas		298,550	373,300	374,850
Southwest Texas		180,250	211,350	174 700
Coastal Texas		242,350	283,450	185,800
TOTAL TEXAS	1,324,000	1,232,500	1,428,250	1,169,900
North Louisiana		78,550	77,350	63,150
Coastal Louisiana		240,350	248,350	216,950
TOTAL LA.	304,000	318,900	325,700	280,100
Arkansas	77,000	73,300	72,700	72,400
Mississippi	21,000	[2] 47,750	28,500	11,750
Illinois	384,800	357,650	339,100	406,650
Indiana	22,200	[2] 20,350	21,300	14,750
Eastern (not incl. Ill. and Ind.)	102,100	94,800	92,500	91,700
Michigan	37,200	42,450	37,800	54,750
Wyoming	88,400	82,600	77,700	69,300
Montana	19,900	20,400	19,250	18,750
Colorado	5,100	4,000	3,950	3,550
New Mexico	108,600	109,750	111,400	105,050
TOTAL EAST OF CALIF.	3,222,300	3,062,050	3,221,050	2,891,950
California	624,800	633,200	626,200	601,600
TOTAL U. S.	3,847,100	3,695,250	3,847,250	3,493,550

[1]These are U. S. Bureau of Mines' calculations of the requirements of domestic crude oil based upon certain premises outlined in its detailed forecast for the month of July. As requirements may be supplied either from stocks, or from new production, contemplated withdrawals from crude oil inventories must be deducted from the Bureau's estimated requirements to determine the amount of new crude to be produced.

[2]Oklahoma, Kansas, Nebraska, Mississippi, and Indiana figures are for week ended 7 A.M., July 30.



Transportation

Transportation holds a master key to the successful promotion of our defense program. Transportation of petroleum products in huge quantities is imperative, for oil is the life blood of mechanized and mobile equipment.

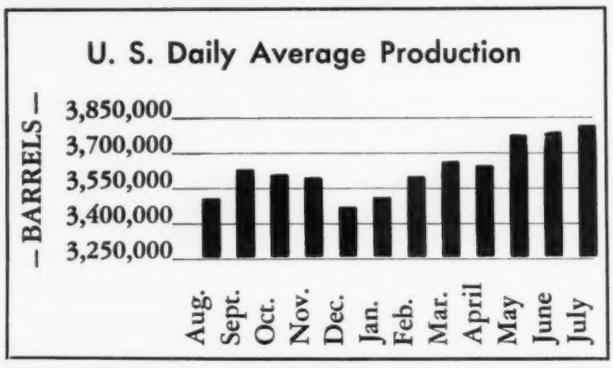
Facilities for handling these huge quantities will be put to an unprecedented test, but the demand can and will be met.

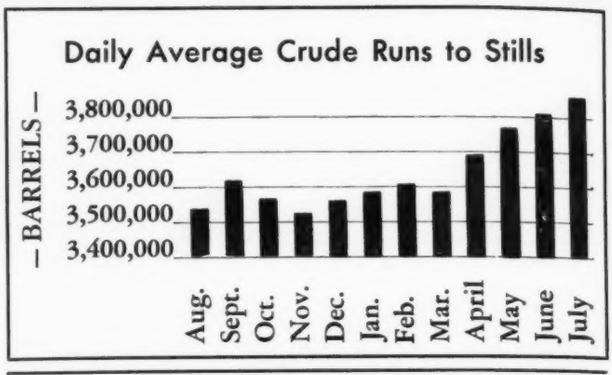
While the Oil Industry has been busily engaged in increasing known oil reserves threefold since 1917, it has not neglected the development of vital Transportation facilities. During this time the number of tank cars has been doubled; pipeline capacities have been tripled; oil tankers have been increased 900%. These are encouraging facts—eloquent testimony to the ability and foresight of our 20th century pioneers, the American oil men.

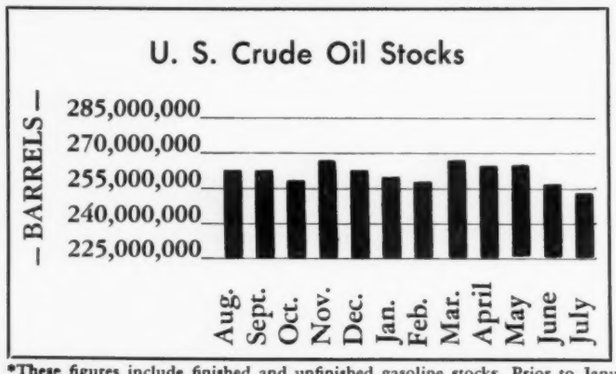
DOWELL INCORPORATED
Executive Office: Midland, Michigan

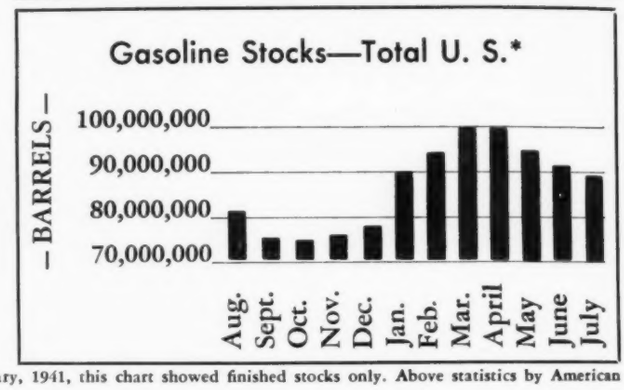
General Office:
KENNEDY BLDG., TULSA, OKLAHOMA
Subsidiary of The Dow Chemical Company

PETROLEUM *Statistics* AND FIELD *Operations*









*These figures include finished and unfinished gasoline stocks. Prior to January, 1941, this chart showed finished stocks only. Above statistics by American Petroleum Institute.

Summarized Operations in Active Fields for July, 1941

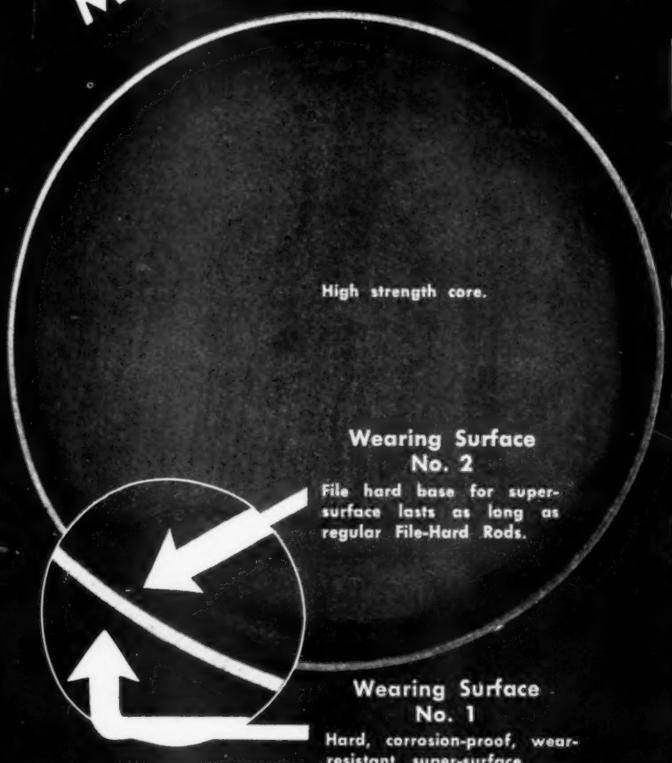
Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	100	81	16	31	3500-3700	2	40	Rotary
Gaines County	13	13	3	9	4400-5584	2	22-35	Rotary
Hockley County	61	61	12	29	4800-6850	2	20-30	Rotary
Ector County	33	32	12	37	3675-4377	2 or 3	32-36	Rotary
Panhandle	75	75	24	68	1700-3900	2	40	Rot.-Cab.
Nueces County	25	20	7	18	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	39	37	10	23	3730-3935	2	42-43	Rot.-Cab.
Hawkins Field	16	16	9	14	4495-4912	2	19-29	Rotary
OKLAHOMA								
Okfuskee County	9	8	8	3	2150-4125	2 or 3	38	Rotary
KANSAS								
Russell County	51	42	10	21	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	12	8	4	8	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	40	31	17	23	3290-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	448	338	292	263	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	14	13	7	12	3150-4030	2	30-34	Rot.-Cab.
CALIFORNIA								
Kern County	35	30	14	20	1840-11,450	3 or 4	14-30	Rotary
Wilmington	15	15	6	3	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for July, 1941

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1940 (In Barrels)
	July	June	July	June	July	June	July	June	July	June	
Arkansas	16	16	5	10	20	16	11	8	38	34	25,699,000
California	130	97	17	86	136	119	100	97	161	156	224,029,000
Colorado	1	13	1	11	....	....	10	15	18	35	1,369,788
Illinois	448	357	338	280	518	395	292	288	148	141	146,572,938
Indiana	49	38	21	20	49	40	22	20	46	72	4,946,384
Kansas	255	187	68	137	230	258	35	40	295	288	65,602,452
Kentucky	26	28	12	15	26	32	7	9	62	88	5,282,335
Louisiana	164	105	54	75	187	150	47	45	261	270	103,738,728
Michigan	89	56	32	32	98	65	40	37	133	146	19,768,984
Mississippi	17	14	1	12	....	....	8	8	31	33	4,313,159
Montana	11	16	5	14	....	....	6	8	23	31	6,663,872
Nebraska	8	4	5	2	9	15	5	4	14		267,533
New Mexico	24	20	10	16	47	35	24	21	76	94	38,893,898
New York	133*	94*	....	94*	....	....	23	14	88	80	4,240,441
Ohio	166	136	40	98	....	....	51	47	192	190	3,132,280
Oklahoma	211	180	46	132	262	203	68	61	203	195	152,516,049
Pennsylvania	287*	207*	8*	198*	....	....	17	13	85	79	17,987,217
Texas	1126	810	245	630	1439	1247	813	718	1736	1845	490,101,261
West Virginia	64	44	11	40	....	....	21	18	129	149	3,586,653
Wyoming	10	16	1	15	....	....	12	17	11	16	25,863,538
Total	3379	2438	920	1917	3021	2575	1612	1488	5262	3954	1,344,576,159

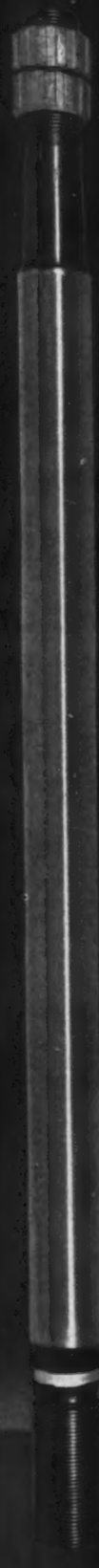
*Includes water-intake and pressure wells.

MISSION *Super-Surfaced* PISTON RODS


High strength core.
Wearing Surface No. 2
File hard base for super-surface lasts as long as regular File-Hard Rods.
Wearing Surface No. 1
Hard, corrosion-proof, wear-resistant super-surface.

DOUBLE SAVINGS

From TWO WEARING SURFACES



This double wearing surface means two to four times longer rod life for users of Mission Super-Surfaced Piston Rods.

WEARING SURFACE NO. 1

This hard, corrosion-proof, wear-resistant super-surface lasts about as long as a regular File-Hard Rod under ordinary conditions . . . and up to three times longer under corrosive conditions.

WEARING SURFACE NO. 2

When the super-surface is finally worn off, a regular Mission File Hard surface remains to give its long period of wear.

LONGER ROD LIFE MEANS LOWER ROD COSTS

From two to four times longer life at only about a 45% increase in price . . . This means lower rod costs any way you figure it. Install these rods in your pumps and start saving right away. Mission Manufacturing Co., Houston, Texas. Export Office, 30 Rockefeller Plaza, New York.

Mission Fluid End Piston with replaceable rubbers on a long life body . . . guaranteed to be the most economical piston on the market to operate.

MISSION

SLUSH PUMP PARTS

Your pumps stay running longer and cost less to repair when equipped with Mission Pump Parts

MAJOR *Pipe Line* ACTIVITIES

PETROLEUM Coördinator Harold L. Ickes has recommended immediate construction of a $70,000,000 pipe line, largest the petroleum industry has ever built, capable of transporting 250,000 bbl. of oil per day to the east coast from East Texas oil fields. The coördinator's recommendation was made following passage of the Cole bill by the Senate. Congressional action on the Cole bill permits exercise of the power of eminent domain in obtaining the rights-of-way for pipe lines declared essential to national defense by presidential proclamation. It also provides that the government may construct the lines if necessary or lend private industry the money for such construction.

Ickes and Deputy Coördinator Ralph K. Davies have held meetings with representatives of a number of major oil companies who have expressed willingness to coöperate in the joint construction of the line. Although the representatives differed on the route and type of the project, they have agreed to abide by Ickes' recommendation.

The 20-in. pipe line will originate in the East Texas oil fields near Longview and proceed to Nashville, Illinois. This unit of the line is to have a capacity of 200,000 bbl. per day. The Illinois terminal will connect with a 16-in. pipe line from Wood River, Illinois, which is the present terminal for pipe lines from the Mid-Continent and Texas fields. This line will have a capacity of 115,000 bbl. per day.

From Nashville, junction of the East Texas and Wood River terminal line, a 24-in. line will be built to the Atlantic Coast, terminating in the Philadelphia, Pennsylvania, and New York refining areas.

Capacity of the 24-in. line will be 250,000 bbl., whereas the capacity of the 20-in. and 16-in. lines from East Texas and Wood River total 315,000 bbl. per day. The excess capacity would assure the 24-in. line of a continuous supply of oil. Route of the pipe line is said to represent a compromise between the major oil companies who want a direct line from Texas to New York. The opposing group, headed by Harry F. Sinclair, requested the so-called northern route.

"So routed," the coördinator said, "the main line, with the necessary feeder line connections, will reach the principal sources of oil production east of the Rocky Mountains, and thus will be supported with a maximum of crude reserves." The line, 1560 miles in length, will provide new outlets for crude oil from Kansas, Oklahoma, northwest and Panhandle areas of Texas, Nebraska, and Wyoming.

Ickes reported that if all the conditions for the construction of the projected pipe line are ideal, a minimum of eight months will be required for construction.

Among the companies included in the joint construction of the line, forming an organization to be known as the National Pipe Line Company, are Socony-Vacuum Oil Company, Cities Service Oil Company, Standard Oil Company of New Jersey, Atlantic Refining Company, Tide Water Associated Oil Company, Shell Oil Company, Inc., Gulf Oil Corporation, The Texas Company, and the Consolidated Oil Corporation.

Directors of the Plantation Pipe Line Company have announced the awarding of four separate contracts for construction of an 800-mile gasoline pipe line from Baton Rouge, Louisiana, to Greensboro, North Carolina, and 200 miles of lateral lines from Bremen, Georgia, to Chattanooga and Knoxville, Tennessee, for a capacity of 60,000 bbl. per day.

Contract for the section of line from Baton Rouge to the Mississippi-Alabama state line was awarded to Latex Construction Company, Houston, Texas. For the line from the Mississippi-Alabama state line to Alabama-Georgia line the contract was let to the Oklahoma Contracting Company, Dallas, Texas. Williams Brothers Corporation, Tulsa, Oklahoma, was given the contract for construction of the line from Alabama-Georgia state line to Greensboro. Williams Brothers will also construct the lateral lines from Bremen, Georgia, to Chattanooga and Knoxville.

Construction of a pipe line to deliver natural gas from southern Louisiana into Tennessee and North Carolina has been announced by The Tennessee Gas and Transmission Company, who plan to begin work immediately.

Curtis B. Dall, president of the company, says that the necessity for federal approval of the project was eliminated when the Federal Power Commission earlier disclaimed jurisdiction of the company's application to construct the line. The line will cost approximately $22,500,000.

A 200-mile pipe line from the southern Louisiana fields near Houma to Mobile, Alabama, is being constructed for the United Gas Pipe Line Company, Shreveport, Louisiana. The line is being laid under the Mississippi River at Luling, Louisiana, overland to Lake Ponchartrain, across the lake to Mandeville, then east past Gulfport, Mississippi, to Mobile to connect with lines to Jackson, Mississippi, and Pensacola, Florida. The pipe varies in size from 10 to 16 in.

Trans-American Pipe Line Company has proposed a $25,000,000 pipe line from Wichita County, Texas, to a deep-water terminal at Savannah, Georgia. In a letter to Secretary Ickes the company states that the proposed line would release 12 to 15 tankers for other service.

The proposed line would be 1050 miles in length, 10 in. in diameter the first 300 miles, and 12 in. the remaining distance. Capacity would be 70,000 to 75,000 bbl. daily.

Operators in the Cement pool of Caddo County, Oklahoma, greatly in need of additional outlet, will be given relief by The Texas Pipe Line Company, which has announced plans to construct an 8-in. pipe line from the Apache pool through the Cement field to its main line at Seminole. The line will be 100 miles in length and will have a capacity of 25,000 to 30,000 bbl. per day.

Dow Chemical Company of Freeport, Texas, is negotiating to lay a system of pipe lines to tap natural gas wells within a radius of 125 miles of the $18,000,000 Freeport plant. Dow plans a $1,000,000 addition to the plant to turn out 150 tons of ammonia per day from hydrogen gas from the Gulf Coast's natural gas wells. The plant, now using about 75,000,000 cu. ft. of gas per day, will need between 180,000,000 and 200,000,000 cu. ft. per day.

Panhandle Eastern Pipe Line Company will lay a $4,633,000 pipe line to serve 66 municipalities in Michigan. The Michigan Public Service Commission recently announced permission for the line. The company will construct the pipe line from a point west of Toledo, Ohio, on the trunk line from Texas and Oklahoma fields. Panhandle Eastern has contracted with Consumers Power Company for 15 years of transportation of natural gas to Michigan from Amarillo, Texas, and Hugoton, Kansas, fields, to substitute for artificial gas. The power company will spend $250,000 to connect to its own line from the Winterfield-Riverside gas fields.

THE Petroleum Engineer

AUGUST, 1941

Designing and Installing Refinery Steam Piping

PETROLEUM ENGINEER Exclusive Feature

☆ Area of steam line, pressure drop, radiation loss, elimination of condensate, and velocities in steam lines are factors to be considered for efficient steam distribution

by R. G. Lovell, Development Engineer, Hancock Oil Company of California

TO DESIGN and install steam piping in a refinery by applying arbitrarily the same rules and principles used in power plant piping is bound to result in unsatisfactory and inefficient operation. There is nothing wrong with the principles. It is simply a matter of their correct application. The steam duties in an oil refinery are not, necessarily, alike in all respects, to those of steam for power generation. Instead of endeavoring to define the essential differences, it will be more helpful if we take up the subject of refinery steam piping on its own merits.

Obviously, inefficient steam distribution will be reflected in fuel consumption, but if, for instance, the plant has been disposing of the non-condensable gases produced in the cracking operation by burning in a flare, the cost of this portion of the fuel is negligible. With the rapid development of polymerization, alkylation, and kindred processes, however, these gases are coming to be considered of definite value as charging stocks. Nor can self-produced dry natural gas longer be given negligible value for the same reason. In any case, it is pertinent to state one of the principles of accounting that applies directly to the matter in hand. In setting up a unit cost for fuel *do not use the selling price*, but rather use the accountant's book cost of production of the fuel. *Goods on hand cannot be valued at their selling price as this involves an anticipated profit.*

Main Factor Affecting Efficiency

All the conditions, of either plus or minus values, that affect the efficiency of a steam line will be found to center upon the area of the line. The problem consists, entirely, of sizing up the other factors that are affected by line size and evaluating them properly from the dual angle of cost and utility.

R. G. LOVELL

received his academic training in New York and served several of the larger mining and milling companies of New Mexico, Arizona, and the Republic of Mexico as power engineer and master mechanic from 1908 to 1917, then saw military service in the engineering corps until 1919—Returning from the war he became affiliated with the oil refining industry, first with Standard Oil Company of California as refinery construction engineer and later with a foreign company—Later he was made assistant to the chief engineer of Pan American Petroleum and Transport Company for the construction of their California processing properties—He has been with The Hancock Oil Company of California since that time.

Pressure Drop

To keep pressure drop between boiler plant and points of use at a practical minimum has always been considered desirable. To many this has seemed to be entirely a question of providing such liberal line size that the loss-of-head-due-to-friction would be low. This is not necessarily the case. It can easily be that pressure drop is greater with large line size than with smaller line.

Radiation Loss

The loss of heat from the steam due to radiation is governed by the nature of the steam—normal or superheated—by the differential in temperature between the steam and the surrounding air, by the number of sq. in. of pipe exposed to the outside air and by the length of time in which any one cu. ft. of the steam is so exposed during its passage from boiler to point of use. The thickness of the pipe wall has so little to do with the matter that it well may be neglected. As the time factor increases, due to low velocity, the loss of heat from a unit volume becomes greater and more condensation takes place. Condensation increases specific volume, or, conversely, decreases the specific gravity—density—of the steam, both being reflected by lowered pressure. So then, liberal pipe

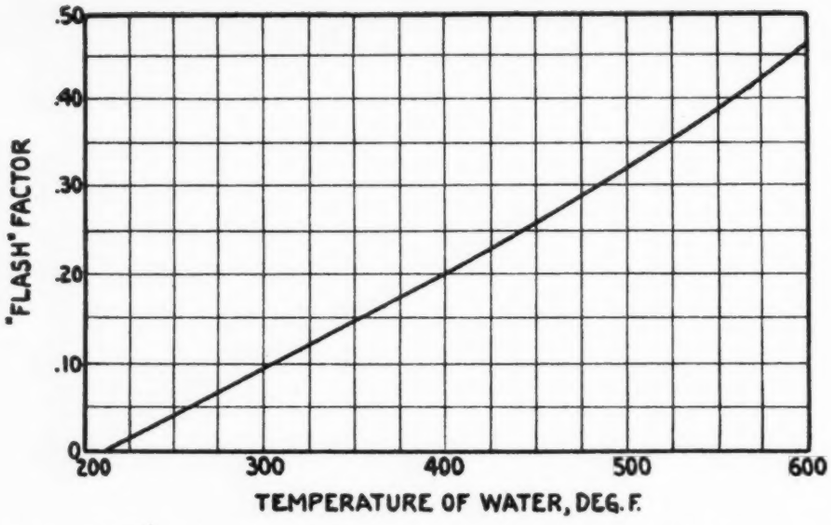


Fig. 1. This chart gives the "steam flash" factor for a range of water temperatures from 212° to 600°F.

size is not always a desirable thing, no matter whether the steam is to be used for driving a pump or as a heating medium.

Eliminating Condensate

Ratios of steam-to-liquid cylinder areas in refinery pumps are generally very liberal and little necessity is found for maintaining high throttle pressures. It is much more important to supply dry steam to the pump or heater for several varied reasons that will be explained later. It is entirely possible and practicable so to handle this proposition. It is known that the condensate formed in the line is carried along on the bottom of the pipe in the direction in which the line is graded, but that some part of the water will be entrained with the steam. The relative amount of water so entrained is governed, in a considerable degree, by the steam velocity. To permit the water to drop out consists of lowering this velocity markedly for a very short distance by providing an enlarged section of the line just ahead of point of use. Then drain off the dropped-out water through a conventional steam trap.

There are a multitude of ways to accomplish this, depending upon the position of the line. The method should not be considered as taking the place of the conventional cast-iron or steel steam separator. The latter device is carefully designed and manufactured to remove the water from steam that is moving at normal velocities, and the enlarged section and baffling in the separator accomplishes this, but in order to function as the designer intended, the size must be selected with a view to the amount and quality of steam to be handled at this normal velocity. Size of line in which the separator is connected should not, necessarily, be used as the proper size of separator. Too small a separator means too high velocity through it, with resultant incomplete separation. A formula that is often used for determining separator size is:

$$C = \frac{A \times B \times 2.4}{V}$$

in which C = area of inlet, sq. in.
A = volume, cu. ft. of 1 lb. of steam at the given pressure
V = velocity, ft. per min.

The source of this formula states that "the velocity should be figured as being 7000 ft. per min., maximum." In the quoted statement lies the weakness of the formula. The 7000 ft. per min. velocity, specified as a maximum, can, and should be, exceeded, for reasons already pointed out. It will be observed also, that, according to the formula, the area of inlet can be decreased as velocity increases. This may all be very well from the angle of lesser drop-out of water with high velocity, but it must be remembered that high velocity also invites entrainment of the smaller droplets with consequent increased difficulty of separation.

The other stock argument against high steam velocity is the increased hazard of water hammer. When water is being carried along a steam line its direction of flow is governed primarily by the line gradient even if the steam flow is in the oposite direction. For obvious reasons it is desirable that both be flowing in the same direction and, in that case, the velocity of the water is, of course, accelerated by the steam velocity. The potential force of this water, when it encounters any obstacle tending to arrest the flow or to divert its direction, is according to the square of both the weight of the body of water and its velocity. To retain the advantages of high steam velocity and, at the same time, avoid the hazard attendant upon the high water velocity amounts only to providing means for the water to follow a straight line to a "blind siding"—a condensate receiver—where means are provided for its disposal. It should be noted that one receiver and one trap of ample size can serve several drains. The trap connection should not be taken off from the bottom of the receiver. This in order to allow some space for the accumulation of dirt and scale, which should be blown out from time to time. The accompanying photographs show how this is sometimes done.

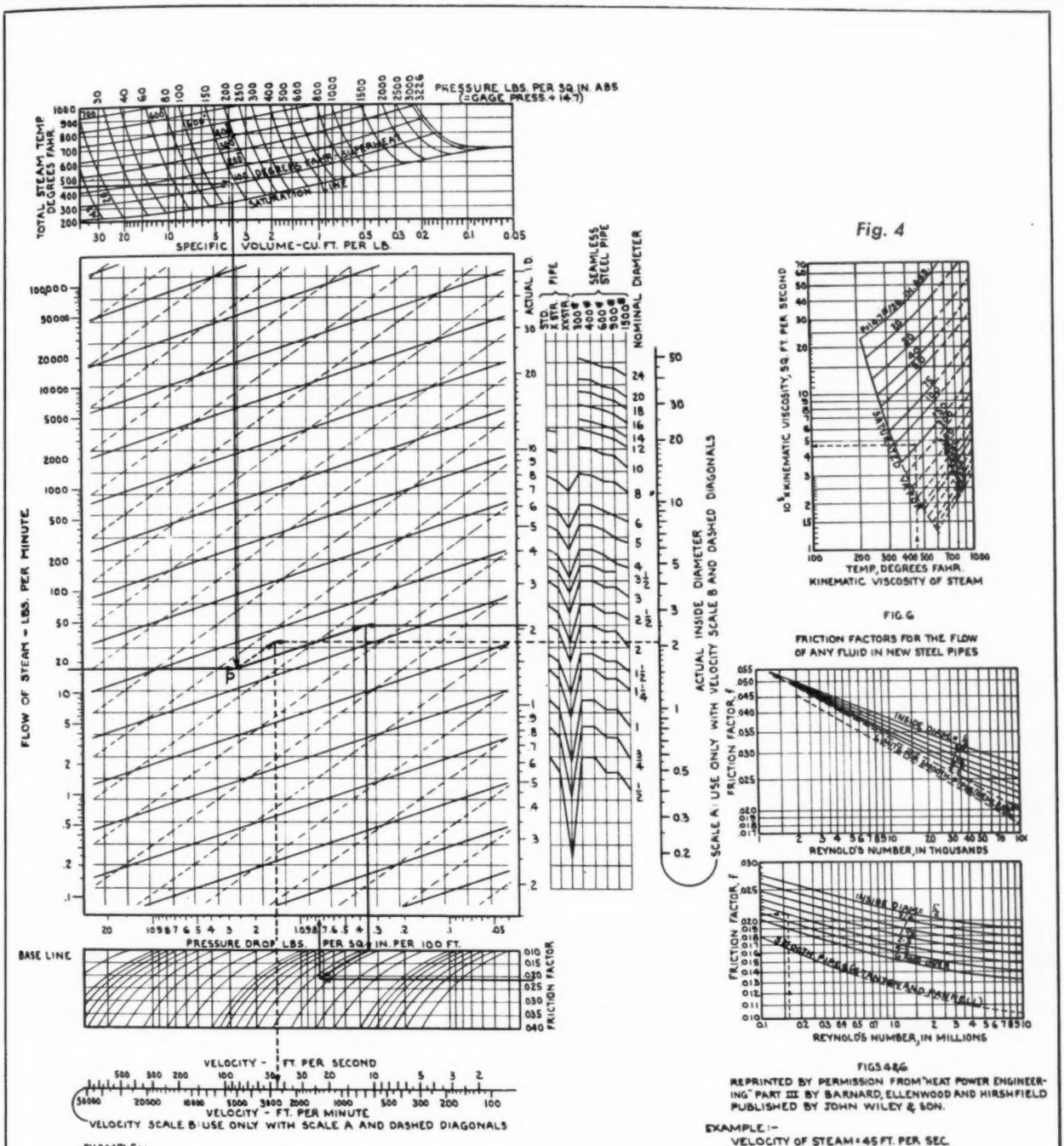
In selecting type of trap one can be guided by the recommendations of any reliable manufacturer. An impulse trap will do one kind of job satisfactorily but it cannot be expected, at its price, to do all the work done by a bucket trap. Selecting the particular make of trap is not of great importance as they are all good. This is much like the selection of a pump. If the user knows exactly what duty he wants from the equipment, and will state those requirements, he can safely be guided by the judgment of the equipment manufacturer. Steam trap size selection should not be made by pipe size, but by pounds of water per hour to be voided from the line.

Steam Flash

When water is discharged from a steam trap, at a temperature higher than that into which it discharges, a certain percentage of this water flashes into steam, which is often mistaken for live steam and the trap therefore condemned.

When a quantity of water is partly converted into steam at atmospheric pressure, there are 180 B.t.u. in each pound of the remaining water and there were 1150 B.t.u. in each pound of the steam. The difference between these two values is 970 B.t.u., which is the *Latent Heat of Evaporation* of the steam at atmospheric pressure. The temperature of the steam and water is exactly the same (212°F., at atmospheric pressure.) This exact equality of temperature is true of every saturated steam condition where water is in direct contact with the steam.

Suppose now, for example, that steam at 250 lb. per sq. in. absolute pressure is condensing and the condensate is discharging through a trap into the atmosphere. From steam


PRESSURE LBS. PER SQ. IN. ABS (=GAGE PRESS. + 14.7)
TOTAL STEAM TEMP DEGREES FAHR.
SATURATION LINE
SPECIFIC VOLUME-CU. FT. PER LB.
FLOW OF STEAM - LBS. PER MINUTE
ACTUAL I.D.
PIPE
STD.
X STR.
XXSTR.
SEAMLESS STEEL PIPE
NOMINAL DIAMETER
ACTUAL INSIDE DIAMETER
SCALE A: USE ONLY WITH VELOCITY SCALE B AND DASHED DIAGONALS
PRESSURE DROP LBS. PER SQ. IN. PER 100 FT.
BASE LINE
FRICTION FACTOR
VELOCITY - FT. PER SECOND
VELOCITY SCALE B: USE ONLY WITH SCALE A AND DASHED DIAGONALS

EXAMPLE:-

GIVEN-

LBS. OF STEAM FLOWING PER MINUTE = 17[#]
STEAM PRESSURE = 140[#]/SQ. IN. ABS.
STEAM TEMPERATURE = 453°F. (353°+100° SUPERHEAT)
SIZE OF PIPE = 2" STANDARD

REQUIRED-

VELOCITY AND PRESSURE DROP

PROCEDURE.-

ENTER AT 453°F. TOTAL STEAM TEMPERATURE.- RIGHT TO 140[#] ABSOLUTE PRESSURE.- DOWN TO 17[#] OF STEAM PER MINUTE- FOLLOW DASHED DIAGONALS TO INSIDE DIAM. OF 2" STD. PIPE USING SCALE A-DOWN TO 2700 FT. PER MIN. VELOCITY OR 45 FT. PER SEC. -DETERMINE FRICTION FACTOR FROM REYNOLD'S NUMBER (SEE FIGS. 4 & 6)- - - -PROCEED FROM POINT "P" PARALLEL TO SOLID DIAGONALS TO HORIZONTAL LINE THROUGH 2" STD. PIPE SIZE-DOWN TO BASE LINE- FOLLOW CURVED FRICTION FACTOR LINES TO FRICTION FACTOR OF 0.0213 - UP TO PRESSURE DROP OF 0.75[#] PER 100 FT. OF PIPE.

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Fig. 4

FIG. 6

FRICTION FACTORS FOR THE FLOW OF ANY FLUID IN NEW STEEL PIPES

FIGS. 4 & 6

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EXAMPLE:-

VELOCITY OF STEAM = 45 FT. PER SEC.
STEAM PRESSURE = 140[#]/SQ. IN. ABS.
STEAM TEMPERATURE = 453° F.
SIZE OF PIPE = 2" STD.

REQUIRED:-

FRICTION FACTOR "f"

PROCEDURE:-

DETERMINE REYNOLD'S NUMBER

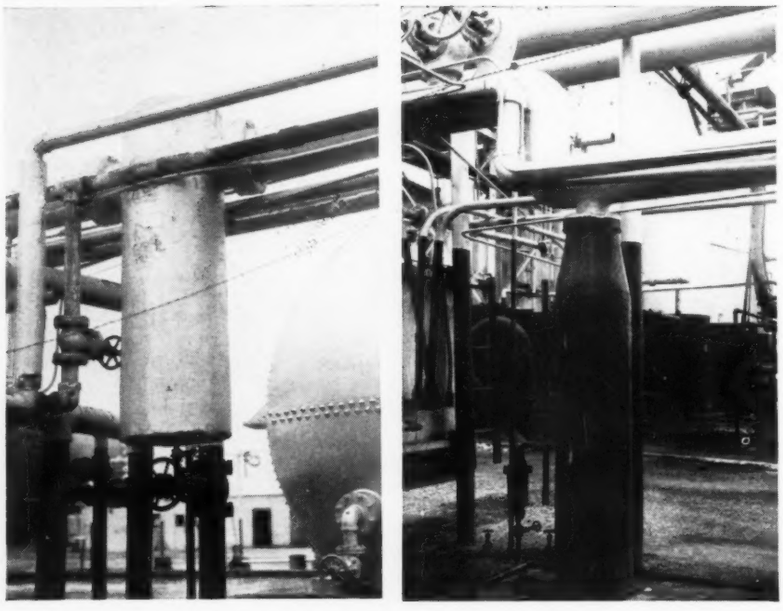
$$R = \frac{\text{DIAM OF PIPE IN FEET} \times \text{VELOCITY-FT/SEC.}}{\text{KINEMATIC VISCOSITY}}$$

THE KINEMATIC VISCOSITY IS GIVEN IN FIG. 4. ENTER AT 453° F AND PROCEED UPWARD TO INTERSECTION WITH 140[#] ABSOLUTE PRESSURE, THEN TO THE LEFT TO A KINEMATIC VISCOSITY OF

$$\frac{47}{10^5} = .000047. \quad \text{THEREFORE:-} R = \frac{\frac{2.067}{12} \times 45}{.000041} = 165{,}000$$

ENTER FIG. 6 AT 165,000 (REYNOLD'S NO.) AND PROCEED UP TO THE INTERSECTION WITH THE LINE FOR 2" PIPE, THEN TO "f" OF .0215.

Fig. 2. Flow of steam through pipes



Types of steam traps used in refinery steam lines. Valves at bottom of traps used to blow-out accumulation of dirt and scale

tables it is noted that the temperature of the steam and condensate is 401° F., and that the heat content of the water at this temperature is 376 B.t.u. In order to determine the quantity of water that will be converted into steam, subtract the heat content of water at 212° F. and atmospheric pressure, which is 180 B.t.u., from the heat content of water at the discharge pressure, which is 376 B.t.u. in this case. Divide this value by the *Latent Heat of Evaporation* at 212° F. and atmospheric pressure. The result is the percentage of each pound of water converted into steam at atmospheric pressure. The equation is stated as follows:

$$\text{Flash factor} = \frac{376 - 180}{970} = 0.202.$$

If the pounds of water discharged in a certain time is known the quantity of steam formed can be determined by multiplying this quantity by the flash factor. For instance, in the above case, 100 lb. of water was discharged in one hour, the quantity of water converted into steam is 100 x 0.202 or 20.2 lb.

The accompanying chart (Fig. 1) gives the "steam flash" factor for a range of water temperatures from 212 to 600°F.

If the trap is discharging into a closed receiver, or into a common line, which is receiving many other trap discharges and/or steam pump exhausts, the flashing of the water into steam may cause a back pressure that can be detrimental to the operation of the trap. This problem should be investigated thoroughly before the size of trap is specified.

Reasonable Steam Velocities

The expression, reasonable steam velocity, is *not* reasonable unless one defines the limits of reason and marks them so clearly that they will not easily be exceeded.

In lines of not more than 300 ft. in length it is entirely reasonable to allow velocities of from 1000 to 1200 ft. per min. per in. of inside diameter, the higher value applying particularly to sizes above 12 in. This specification is with the idea of allowing for the proportion—the square—between area and diameter. With the same factors in mind it is safe to say that saturated steam of 95 percent quality and at pressures of 50 lb. per sq. in. and up can be allowed a velocity of from 6,000 to 10,000 ft. per min., whereas velocities of from 7,000 to 20,000 are considered good practice for superheated steam at pressures of 200 lb. and up.

Velocities in steam lines to reciprocating units should not be more than 65 percent of that to turbines, or any other service where the flow is continuous. The velocities noted apply equally well to both high- and low-pressure steam, as the reduction in friction at low pressure, due to the reduced density, about offsets the condition that less initial pressure is available to suffer the pressure drop.

Pressure drop through pipe is, approximately, inversely proportional to the specific volume of the steam if the velocity is the same, i.e., if the pressure drop through the pipe is known at 50 lb. per sq. in. (specific volume 6.65) the pressure drop at 100 lb. per sq. in. (specific volume 3.88) will be, approximately, 6.65/3.88, or 1.72 times the drop at 50-lb. pressure, with the same steam velocity.

Steam Flow Chart

The general flow formula for determining the pressure drop in pipe lines transporting steam has been developed in chart form as shown. (Fig. 2.) This chart is not difficult to use and, in addition to covering the friction losses, and consequent pressure drop, there are a number of new features included. Not only is it possible to solve problems in steam flow involving the pressure-drop-due-to-friction, but it is also easy to solve where velocity is to be an important factor.

A very useful feature of this chart is that it provides a convenient means of finding the specific volume of steam at any pressure and temperature without referring to steam tables. Superimposed upon the chart will be found a solid, heavy, black line, with arrows at intersecting points, which represents a typical example involving friction pressure drop as a factor.

Reynold's Number

In the abstract calculations for fluid flow in pipe lines it is necessary that there be some figure used as a coefficient of friction, which will include:

1. Mean velocity.
2. Pipe diameter.
3. Specific gravity.
4. Absolute viscosity.

This criterion is called Reynold's Number and is used in all calculations and charts for fluid flow in pipe lines. There is no reason, within the scope of the present work, to explain the details of how this criterion is made up and reference to it is made only for general information.

Typical Steam Flow Problem

As the Reynold's Number is the controlling element in determining the friction factor, it is necessary that the velocity of the steam through the pipe be known, or assumed, as this value is used in determining the Reynold's Number.

Refer to the procedure on the chart and follow through the example given. Then set up other values and work out a solution to those. A little practice is all that is required to make anyone proficient in the use of the chart, and the ease and rapidity with which accurate results can be obtained will be surprising.

Acknowledgment

Acknowledgment is made to Crane Co., Chicago, Illinois, for permission to reproduce Figs. 1 and 2 in this article. These appear in Crane Co.'s publication, "Engineering Data on Flow of Fluids in Pipes."

Townsite drilling at Hawkins, Texas

Petroleum Exclusive

by *H. Lee Flood*
Associate Editor

Underreaming to Straighten Hole in Well Drilled on Townsite Lot

Underreaming to 30-in. diameter results in wide enough shoulder to permit new hole to be drilled

IN RECENT years, the control of the direction in which the bit is digging in rotary drilling has become a more or less routine part of the job of drilling an oil well. Methods of surveying well bores that determine the compass direction as well as the angle of inclination of a hole that is not vertical are now available at such a relatively low cost that many companies require deviation surveys even when departure from vertical is not of critical importance. When wells are closely spaced, as in townsite drilling, or when wells are drilled bordering on lease lines, it becomes essential to avoid serious deviations from vertical, either to preclude legal complications or to guard against drilling into a neighboring well.

Many devices and methods have been developed for correcting excessive deviations and for returning the direction of a well bore substantially to the vertical.

A different procedure, tried for the first time (so far as is known), was recently employed successfully in one of the townsite wells at Hawkins, Texas. Although the maximum deviation had not become unduly excessive, the operator preferred to straighten the hole and thus avoid the possibility of drilling into one of the nearby wells.

The principal points of interest in the hole-straightening operation rest in (1) the fact that the deviation was corrected before surface pipe had been set and (2) the use of successively larger underreamers (to 30 in.) to create a wide enough shoulder to permit "re-spudding" a new hole that would have a more nearly vertical axis.

Well Data Prior to Straightening

The well had been drilled to a depth of 1221 ft., using three 6⅝-in. by 24-ft. drill collars and a 12¼-in. fishtail bit. At 1221 ft. the fishtail bit was replaced by a 12¼-in. rock bit, and the hole was deepened to 1627 ft.

Knowing that in drilling other wells in the townsite of Hawkins, difficulty had been experienced with crooked hole, the operators were watching the trend of the well carefully. At a depth of 1200 ft. the deviation survey showed the hole to be straight. At the 1300-ft. depth the hole was off one degree; at 1500 ft. the deviation was two degrees, and at 1600 ft. the inclination had increased to three degrees. If the three degree deviation had been maintained, the total horizontal displacement at 4600 ft. (the approximate total depth of wells in this area), would have been 166 ft., computed as follows:

Depths, ft.			*Horizontal*
From	*To*	*Deviation*	*displacement, ft.*
1200	1300	30 min. (avg.)	0.873
1300	1500	1 deg. (avg.)	3.490
1500	1600	2½ deg. (avg.)	4.362
1600	4600	3 deg.	157.020
		Total	165.745

It is probable that the total deviation could have been reduced considerably below this maximum figure without corrective measures. Nevertheless, because of the restricted boundary limitations of the townsite lot, it was considered essential, before the casing string was set, to straighten the hole.

Reaming Unsuccessful

In the initial efforts to straighten the hole, various reaming assemblies were used between depths of 1150 and 1627 ft. These arrangements included different lengths of 7¾-in. drill collars, two- and three-way bits varying in size from 8⅝ to 12¼ in., and regular and special offset 12¼-in. reamers. Six attempts were made to straighten the hole, all unsuccessfully.

Underreaming Operations

It was then suggested that an attempt be made to create a shoulder of sufficient width by underreaming to permit beginning a new hole that would sidetrack the crooked hole.

Accordingly, a wall scraper or underreamer of the expanding blade type was procured and the hole was enlarged in four operations.

The expanding wall scraper tool used on this job consists of an alloy steel body containing a piston to which two blades are connected, the latter being mounted in such a way that the blades retract into the body while running in or out of the hole. At the de-

sired time, the piston may be forced downward by increasing the pump pressure on the mud, thus expanding the blades outward and upward against the wall of the hole. As the drill pipe rotates, the blades cut their way to a fully expanded position and are held in this cutting position by pressure against the shoulder that has been created in the formation. If the formation has a soft consistency the blades are held in their expanded position by pump pressure.

In the first underreaming operation the 12¼-in. hole was enlarged to 15-in. diameter from depths of 1350 to 1400 ft. The 15-in. reamer blades were then removed from the tool and the hole was again enlarged, using 19-in. blades, from 1360 to 1400 ft. The third step consisted of enlarging the hole from 19 in. to 24 in. from depths of 1365 to 1400 ft. Finally, the 24-in. blades were replaced with 30-in. reamer blades and the hole was enlarged to the latter diameter for a distance of 72 ft. (from 1370 to 1442 ft.).

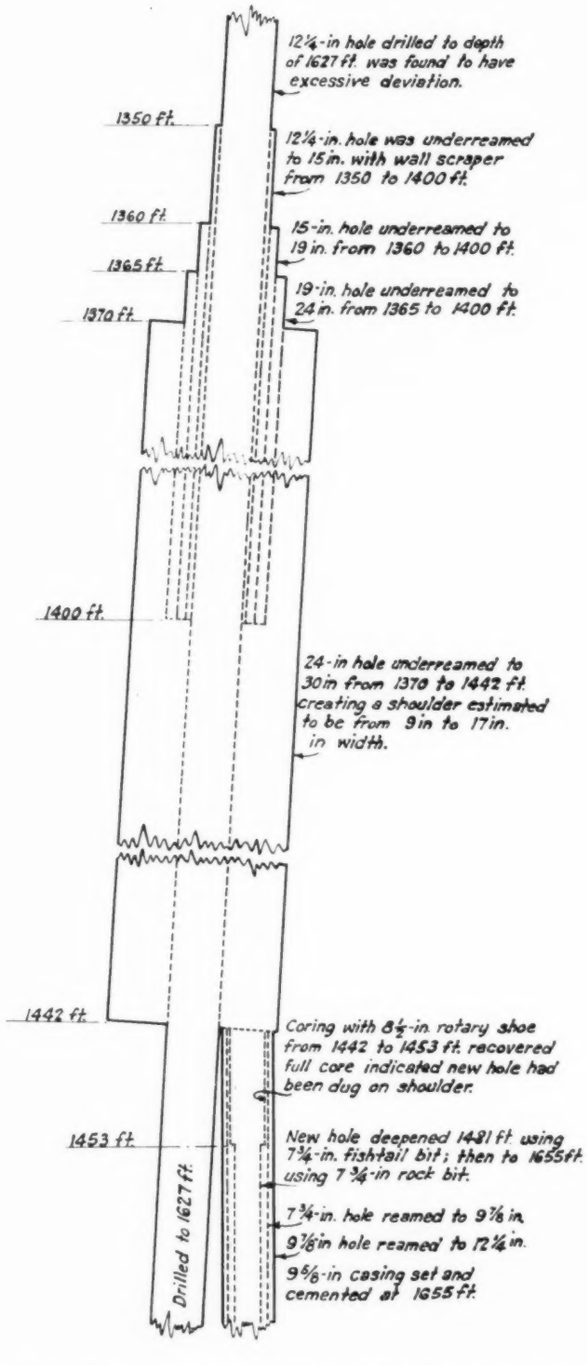
Having thus enlarged the 12¼-in. hole to 30-in. diameter, it was reasonably certain that a sufficiently wide shoulder had been formed to present enough purchase for "re-spudding" without re-entering the crooked hole. If the underreaming tool had remained exactly concentric with the well bore creating a shoulder having the same width around the hole, a minimum shoulder width of (30-12¼) ÷ 2 or 8⅞, say 9 in., would have resulted. Inasmuch as the tool would have been tending to remain vertical, it is probable that the larger hole might have been nonconcentric, thus creating a wider shoulder on the "inside". Maximum shoulder width on the "inside", if the perimeters of the original and enlarged holes coincided on the "outside", would be 30 minus 12¼ or 17¾ in. It is probable that the actual shoulder width was between 9 and 17 in.

In order to begin a new hole and determine, at the same time, whether firm solid rock was being encountered, an 8½-in. rotary shoe and two 6⅛-in. drill collars were used to core from 1442 to 1453 ft. During this operation, the pipe was rotated at extremely slow speed and almost no weight on the shoe. Inasmuch as the success or failure of the attempt would depend largely upon the type of core cut by the shoe, it was with considerable interest that the pipe was pulled out of the hole following the coring operation. A full round core of unfractured rock was recovered, indicating a new hole had been made successfully.

The 8½-in. rotary shoe was then replaced by a 7¾-in. fishtail bit and the new hole was deepened to 1481 ft. At that depth, the fishtail bit was replaced with a 7¾-in. bit of the differential type employing both disk and saw tooth rollers. Using this type bit, the hole was drilled to a depth of 1655 ft.

The 7¾-in. hole was then reamed to 9⅞ in., and then to 12¼ in. Following this, 9⅝-in. casing was set and cemented at 1655 ft.

Deviation surveys taken before the casing was set showed the maximum deviation to be less than one degree. Thus, the underreaming operation was considered entirely successful. It is possible that this method of straightening a crooked hole may suggest to others a way of "getting out of trouble" when other established methods of straightening hole may not appear suitable.


12¼-in hole drilled to depth of 1627 ft. was found to have excessive deviation.
1350 ft.
12¼-in. hole was underreamed to 15 in. with wall scraper from 1350 to 1400 ft.
1360 ft.
15-in. hole underreamed to 19 in. from 1360 to 1400 ft.
1365 ft.
19-in. hole underreamed to 24 in. from 1365 to 1400 ft.
1370 ft.
1400 ft.
24-in hole underreamed to 30 in from 1370 to 1442 ft. creating a shoulder estimated to be from 9 in to 17 in. in width.
1442 ft.
Coring with 8½-in. rotary shoe from 1442 to 1453 ft. recovered full core indicated new hole had been dug on shoulder.
1453 ft.
New hole deepened 1481 ft. using 7¾-in. fishtail bit; then to 1655 ft. using 7¾-in rock bit.
Drilled to 1627 ft.
7¾-in. hole reamed to 9⅞ in.
9⅞ in hole reamed to 12¼ in.
9⅝-in. casing set and cemented at 1655 ft.

Illustrating sequence of hole-straightening operations

Compressor building and a part of the processing equipment

PETROLEUM ENGINEER Exclusive Feature

by

Frank H. Love
Managing Editor

Cycling Plant in Swamp Area Permits Profitable Operation of Isolated Wells

☆ In South Louisiana, small unit takes production from two 10,000-ft. wells —Operation is at high pressures; discharge to key well at 4200 lb.

TWENTY-FOUR miles northeast of New Iberia, Louisiana, on Splice Island Chute, which is in the upper part of the Atachafalaya River, The Texas Company has constructed and is operating a cycling plant that is of interest because it demonstrates the manner in which a few wells in an isolated area can be operated profitably that otherwise might be of little value to their owner. It is of interest, too, because of its exceptionally high operating pressure.

The plant is small, having but one compressor and handling only 8,000,000 cu. ft. of gas per day. Two producing wells, whose depths exceed 10,000 ft. are connected to the plant and gas is returned to a single injection well. The output of the plant, which operates on the straight retrograde separation principle, is approximately 200 bbl. of condensate per day.

The Mongoulois plant, which takes its name from the Lake Mongoulois dome on which the wells are drilled, is situated in the swampy area of South Louisiana. All materials used in building the plant had to be brought in by boat and transportation of the workmen to and from the job is by the same means.

Gas Heated

The plant and injection well are on the west side of the Atachafalaya River and the producing wells are on the east side, about 600 ft. distant. Lines from the wells to the plant pass through the river and during cold weather when the river water temperature drops to as low as 49°F. it is necessary to heat the gas before it enters the river and again when it emerges on the other side to prevent hydrate formation. Immediately before entering the river the gas streams from the two producing wells merge in a common line and pass through a water bath type heater. On the west side of the river, which is the side nearest the plant, the gas flow passes through a second heater of the same type. The first unit heats the gas to a temperature of 110°F. By the time the gas reaches the west side of the

Jacket water and engine oil are cooled by a 93-in. diameter radiator

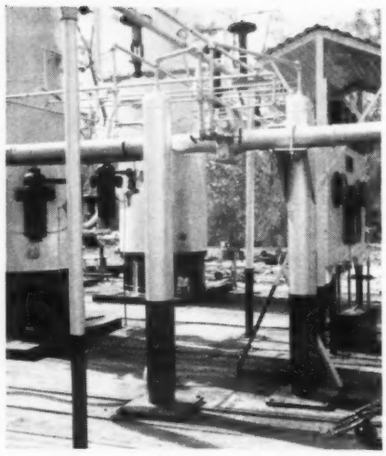
river this temperature has been reduced to about 80°F. and in the second heater this is increased to 100-105°F.

Gas Cycle

The incoming line is operated at full well pressure (approximately 3800 lb.) until an adjustable choke in the line at the plant is reached where the pressure is reduced to about 2500 lb. After the gas leaves the adjustable choke it flows into a primary scrubber. Both condensate and gas then pass through an automatic choke into a separator, the choke maintaining approximately 1100-lb. pressure on the separator. Immediately ahead of the automatic choke, calcium chloride solution is introduced to prevent hydrate formation in the separator. Residue gas from the separator passes through an orifice meter, a final scrubber, thence to the compressor. Intake is at 1100-lb. pressure and 40°F. temperature. Discharge to the injection well is at a pressure of 4200 lb. The injection line is 400 ft. long and is of 2½-in. double extra heavy pipe.

Processing

Condensate from the separator passes into the primary flash tank, operated at a pressure of 250-lb. gauge and a temperature of 47°F. Solution gas from this flash tank passes to the plant fuel system. Condensate from the flash tank flows into a second flash tank that is operated at a pressure of 45-lb. gauge and a temperature of 44°F. From this tank, solution gas also passes to the plant fuel system. Condensate from this final flash tank flows directly to three 1000-bbl. storage tanks. The condensate is transported to refineries entirely by barge, which tie-up at the plant site and are loaded by gravity flow.



Meter setting between separator and final scrubber

The compressor is a 600-hp., V-angle type unit having three forged-steel cylinders of 3¼-in. bore and 14-in. stroke.

Water and Oil Cooling

Cooling of jacket water and oil for the compressor engine is accomplished by means of a large radiator. The 93-in. diameter radiator fan having adjustable-pitch blades is driven by V-belts from the lineshaft. The engine flywheel is equipped with a sheave to drive a lineshaft, which in turn drives the calcium chloride solution pump, an electric generator, and the radiator fan mentioned. The radiator is a combination oil and jacket water cooler. The coil cooler through which the lubricating oil circulates is mounted between the water core and the fan and covers the full radiator area. Normal (middle) setting of the fan blades causes 68,000 cu. ft. of air per min. to be circulated. High and low pitch settings permit an increase of 17½ percent and a decrease of 20 percent from normal cooling capacity, respectively. Makeup water for the jacket cooling system is from a 1700-gal. tank supplied by rainwater.

Foundations and Supports

The engine foundation is mounted on 45-ft. piling, which was driven until only 15 to 18 in. extended into the concrete mat when poured. As a precautionary measure against possible movement of the foundation after the engine was installed and in operation, a considerably larger quantity of concrete than normal was used. Piling under the foundation was driven on 4-ft. centers in both directions.

The compressor building is supported on piling capped by a 6-in. by 8-in. timber. Floors were constructed of 3 by 12s. All lumber including piling was creosoted. All vessels and equipment outside the building are on a platform constructed of 3 by 12s and supported by piling having 6 by 8 capping.

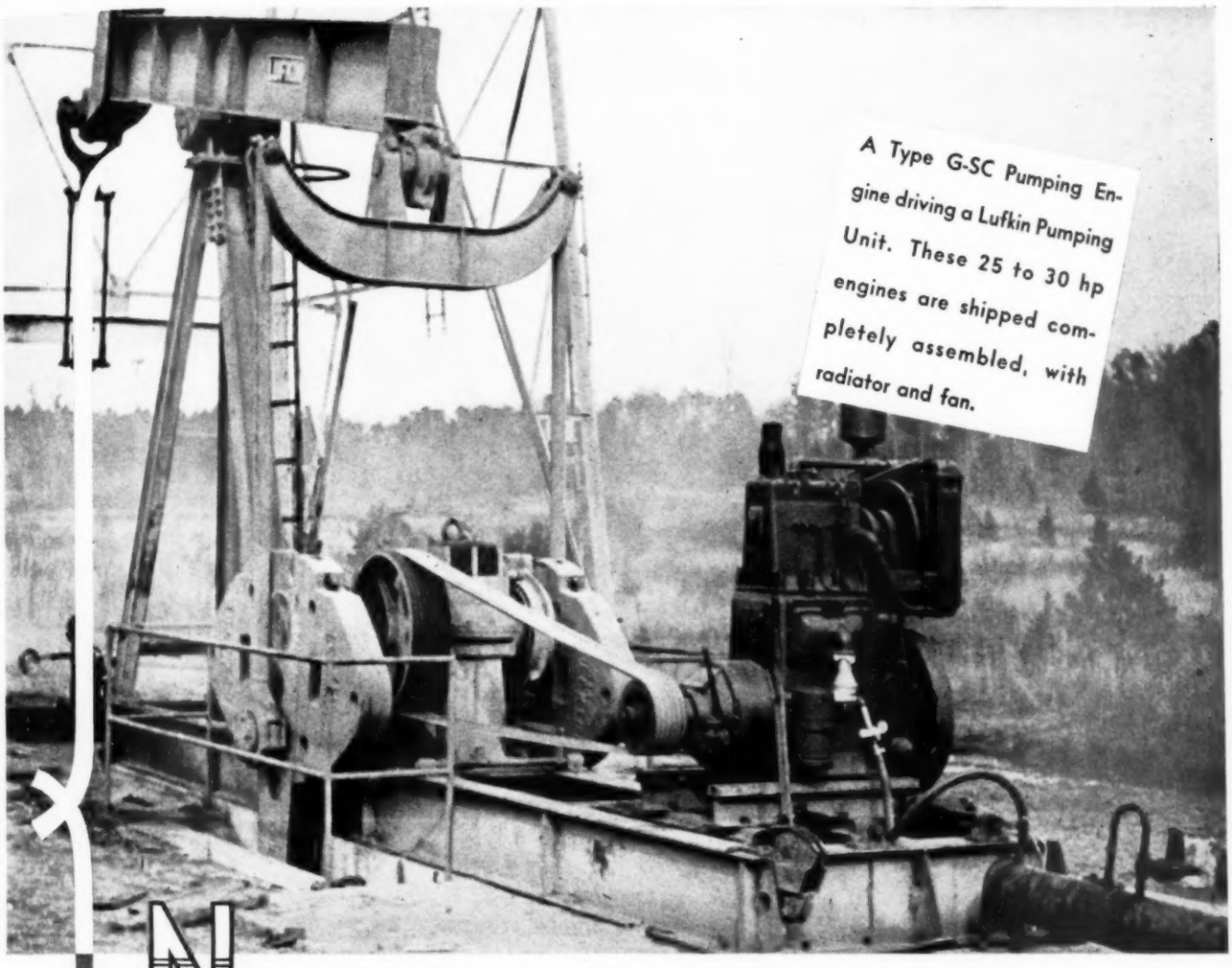
The engine room floor is 3 ft. above ground level and the operating platform is 2 ft. above ground level. The compressor building is 24 ft. by 36 ft. and the operating platform 36 ft. by 32 ft.

Field Lines

From the producing wells to the final gas heater, field lines are of 2-in. seamless upset tubing; from this heater to the adjustable choke the pipe is 2-in. double-extra-heavy seamless tubing. The lines are laid aboveground to the final heater, being anchored in concrete piers spaced 40 ft. apart. From the last heater to the plant the piers are 15 ft. apart and the lines are clamped to the piers. This practice has been observed both on discharge and suction lines.

As a safety measure, the plant is protected with cylinder-operated plug valves so that in an emergency the flow of gas from the producing wells can be stopped immediately and the entire plant system bled-off to a safe distance from the location. The valves are operated by means of pilot valves placed at various points throughout the plant.

Water bath type heater employed to heat the gas before it arrives at the plant



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Development of Seminole Area an Interesting Chapter in Petroleum History

PETROLEUM ENGINEER Exclusive Feature

☆ Many drilling and production problems overcome in exploitation of area classed among greatest of the high-gravity oil fields of the world

PART 1

by Floyd L. Swindell, Consulting Engineer

HAVING produced in excess of 1,000,000,000 bbl. of high-gravity crude oil the Seminole area of Pottawatomie and Seminole counties, east central Oklahoma, undoubtedly should be classed among the greatest of the high-gravity oil fields of the world. On July 16, 1941, which marked the end of the fifteenth year since discovery of large initial production from the Wilcox sand, it was estimated that the area had produced 904,745,518 bbl. of oil, exclusive of the pools in the Wewoka district and the more recently discovered pools in the Seminole district. Recovery figures for the latter are not now available but a conservative estimate would place their production at more than 100,000,000 bbl. Other high-gravity pools have exceeded the Seminole area in total recovery but in view of the fact that more than half of the Seminole oil sold at from $1.23 to $2.39 weighted average per bbl, it is doubtful that any other field has yielded the gross return that operators in this great area have obtained. Upon the basis of 904,745,518 bbl. recovery and a weighted average posted price for oil, the area showed a gross return of $1,108,767,601.12 on its fifteenth anniversary.

One of the most outstanding features of the two-county area is the large recovery per acre and the exceedingly large per-acre-foot recovery. In the present survey detailed study has been made of those leases that have produced 50,000 bbl. or more per acre. It is found that the 75 leases falling within this limitation have produced 211,279,000 bbl. from 3050 acres, an average of 69,271 bbl. per acre. This has been obtained from not to exceed an average of 35 ft. of Wilcox sand, indicating a per-acre-foot recovery of almost 2000 bbl. The area, as defined herein, includes 21 pools comprising 39,980 productive acres, which have produced an average of 22,630 bbl. an acre. The 74 outstanding leases, comprising 7.63 percent of the productive acreage, have produced 23.36 percent of the total recovery.

FLOYD L. SWINDELL

graduated in geology from the University of Oklahoma in 1924—Was with the U. S. Bureau of Mines for about 2 years, then with the Federal income tax unit as oil and gas valuation engineer for slightly more than 4 years—Was Kansas-Oklahoma staff representative for *The Oil Weekly* for 6½ years—Since that time has been in engineering, geology, and sales work—At present is practicing as a consulting engineer at Tulsa, Oklahoma.

History of Development

The first oil of commercial value in Seminole County was found in the Wewoka district and it was this discovery that prompted the drilling boom that resulted in what is now known as the Seminole area. On St. Patrick's Day, 1923, the exceedingly wild wildcat test of R. H. Smith and associates brought oil men from over the entire Mid-Continent to Wewoka when it began flowing at the rate of 3500 bbl. daily from a sand at 3150 to 3157 ft. This sand, named in honor of R. H. Smith, subsequently was correlated as the upper member of the Cromwell sand series. Within a short time the second Cromwell was found to be productive and the intense activity that had developed was directed at these two sand members of the lower Pennsylvanian Series. It was not until almost two years later that Wilcox sand production was discovered on what was thought to be the south limb of the Wewoka structure. On December 18, 1925, Magnolia Petroleum Company completed its Skinner No. 1, NW NW NW 5-7n-8e, flowing at the rate of 4000 bbl. daily from sand at 4074-91 ft. This was the first Wilcox sand production in Seminole County.

Approximately three years after the Cromwell sand discovery on the Wewoka structure, Morgan and Flynn found a sand at 3560-80 ft. and obtained an initial production of 200 bbl. daily. This was named the Earlsboro sand and the well, Ingram No. 1, NW NW SE 10-9n-5e, was the discovery well of what is now known as the Earlsboro pool, one of the pools that are encompassed in the Seminole area. It was completed on March 1, 1926. Six days later Indian Territory Illuminating Oil Company discovered the Seminole City pool when its James No. 1, NW NW SE 24-9n-6e, began flowing at the initial rate of 1100 bbl. a day from Hunton lime at 3975 to 4012 ft. The drilling campaign that followed is one of the highlights of the history of the northern Mid-Continent. Within 60 days after discovery of the Seminole City pool, two other important pools had been discovered in the vicinity.

Most of the wells that were being completed at this time were producing from Hunton lime and the sensational initial production being obtained from them was attracting so much attention that discovery of the first Wilcox sand production in the area went almost unreported. On July 6, 1926, Amerada Petroleum Corporation's Jones No. 1, NW NE SE 24-9n-6e, one-quarter mile east of the Hunton lime discovery well in the Seminole City pool, found the top of the Wilcox sand at 4258 ft., was drilled to 4277 ft., and began

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Makers of... Lone Star... 'Incor'... 'Starcor'... 'Texcor'

Independent Oil and Gas Company's and R. F. Garland's Fixico No. 1, first big Wilcox sand producer in the Seminole City pool, caught fire subsequent to its completion.

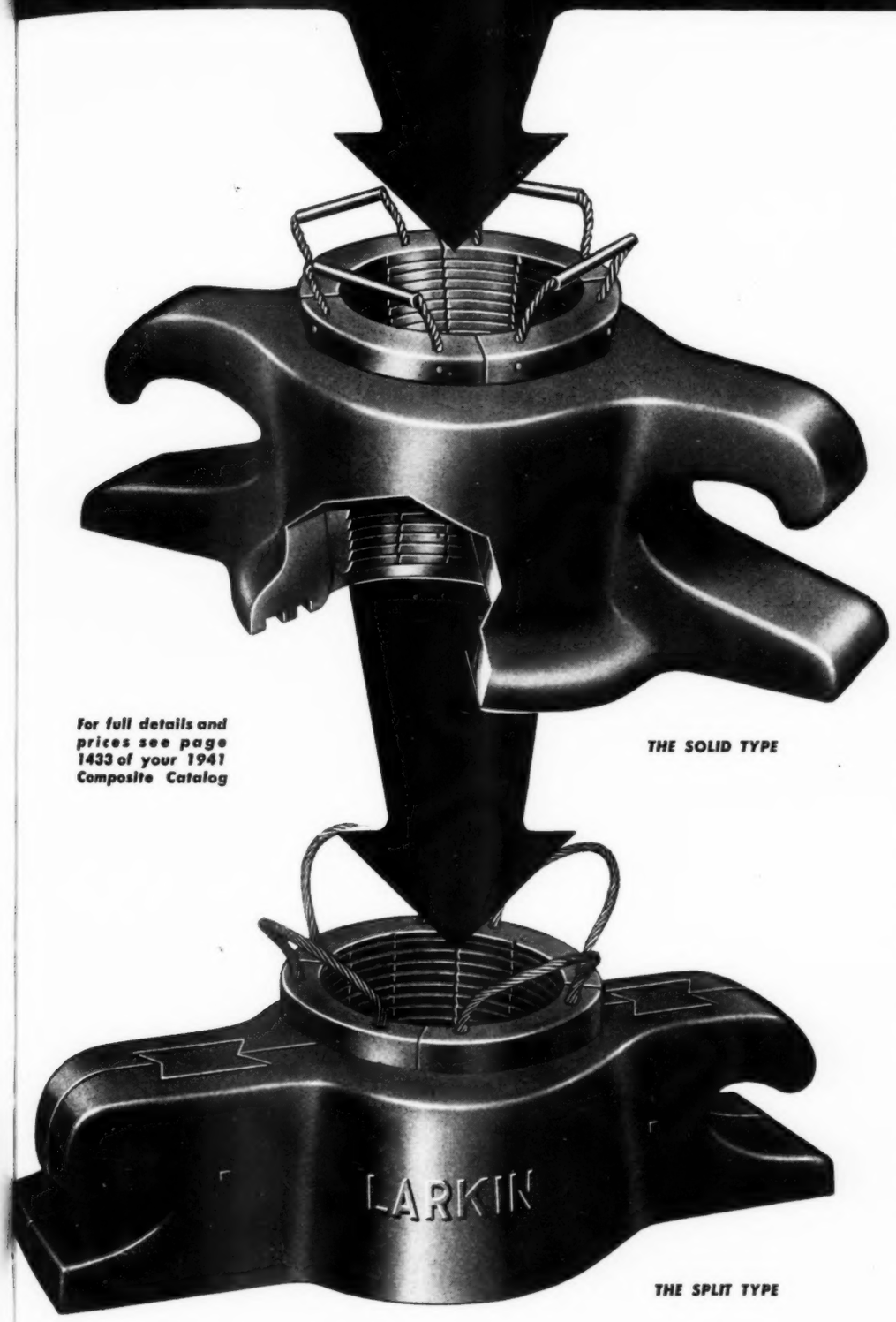
flowing at the unimpressive rate of 60 bbl. per day. In the meantime a young man by the name of Robert Garland of Tulsa had obtained an 80-acre lease approximately one mile southwest of production in the Seminole City pool. After approaching several oil companies in a fruitless attempt to get the lease drilled he succeeded in making a deal with what was then the Independent Oil and Gas Company. The test well was known as the P. Fixico No. 1, NW NW SE 26-9n-6e, and, as it did not show favorably in Hunton lime, was being looked upon as a probable failure. On July 16, 1926, this test found the top of the Wilcox sand at 4065 ft. and was then looked upon with considerably more favor. With a penetration of only 8 ft. the well began flowing as the rate of 6120 bbl. a day, the first gusher production in the area. As Wilcox sand has been the most prolific producing horizon in the area and this was the first large production from any of the wells completed up to that time—the date of its completion, July 16, has been selected as the date upon which to celebrate the Seminole area anniversary. It is interesting to note that the Hunton lime discovery well and the Wilcox sand discovery one-quarter mile to the east of it both were on the east edge of production in the Seminole City pool and the Independent-Garland well was almost exactly on the top of the structure.

Table 1 shows the discovery wells in each of the pools defined herein as part of the Greater Seminole Area, the horizon in which each was completed, total depth, date of completion, 1940 production, estimated recovery to July 16, 1941, and recovery per acre. Wilcox sand discoveries in the pools not originally completed in this horizon are shown in Table 2. About 10 years ago the writer made a study of water encroachment on the various structures in the area and was impressed with the fact that the Bowlegs pool had the most uniform oil-water front of any of the structures then considered. Upon this basis it was predicted that the Bowlegs pool ultimately would have the greatest recovery per acre although at that time it was behind several of the other pools in this respect. From Table 1 it will be noted that the greatest production in barrels of oil has been recovered from the St. Louis pool whereas the Bowlegs pool ranks fifth in total recovery. Its recovery per acre, however, is considerably the greatest and it likely will have the greatest ultimate recovery per acre despite the fact that several of the other pools, such as St. Louis, have yielded considerable amounts of oil from post-Ordovician horizons. The possible reasons for the uniform water encroachment and high recovery per acre in the Bowlegs pool will be discussed in a subsequent paragraph.

Development Problems

The pools of the Seminole area were drilled with rotary tools at a time when very little was known regarding what constituted a proper drilling fluid and how it should be used; also the importance of proper weight on the bit and proper drilling speed was unknown. In the great rush that developed in establishing large production in the Wilcox sand the greatest amount of hole that could be made in the shortest period of time was the all-important aim. Most of the pools in this area, due partly to a system of en echelon faulting, have very sharp local dips in the upper horizons. This condition, coupled with high-speed drilling and maximum weight on the bit, resulted probably in the largest number of crooked holes that ever have been drilled in one area. One instance is known of a hole having a possible drift of almost 500 ft. from vertical and several instances were reported wherein holes were drilled into each other; this despite the fact that most of the drilling was done on 10-acre centers. This information is not presented in criticism of the operators who followed these practices but it does indicate the progress that has been made in the last 15 years in rotary drilling technique. A similar condition existed in the more recently developed Fitts pool, but here great care was exercised with respect to proper weight on the bit, proper drilling speed, and good circulating fluid. The wells at Fitts are almost without exception within one or two degrees of vertical. Geologists who went through the Seminole campaign, particularly the early part of it, are fully qualified for whatever reward there may be in the geologist's Paradise, owing to the great amount of correlation difficulty introduced by crooked holes alone. In the latter stages of development the newly-devised methods for surveying deviation from vertical were adopted, but it has not been possible to date to draw

HANG YOUR CASING HERE



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THE SOLID TYPE

THE SPLIT TYPE

THOUSANDS OF PIPE STRINGS ARE SAFELY SUSPENDED ON LARKIN SPIDERS AND SLIPS

Hundreds of miles of oil well casing are safely hanging today on Larkin Spiders and Slips, thanks to the thoroughness of Larkin's job of design and construction of these important products. Larkin Spider improvements have continuously kept pace with such progressive steps as increased well depths, stronger and heavier casing, safer drilling and producing practice.

The Larkin Solid Type Spider is a recently improved streamline model having an integrally cast flanged base with grooves to fit various casing coupling sizes, thus allowing the spider to be installed centrally on the top coupling of the string. This Spider is chiefly for permanent installations, and the grooved flange serves as a protective cover for the pipe against entrance of foreign matter.

The Larkin Split Type Spider is used to great advantage either on temporary or permanent hook-ups. Assembly is easy. Heavy lifting is eliminated. The two halves are merely slid together and securely locked by the dovetailed key.

Because of increased safety, ease of handling, low initial cost and high salvage value, Larkin Spiders have supplanted the use of clamps with many operators, even on short strings.

Both types function alike . . . forged steel heat treated slips, working on a taper, hold the casing with no pinching or distortion. The spider bodies are highest grade cast steel, precision machined. Strength is proved by independent tests in which a load of 175 tons was applied . . . the equivalent of 17,500 feet of 7" O.D. 20-pound casing.

Larkin Spiders, in all required sizes, are available at your Supply Store.

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a dependable structure map based on top of the Wilcox sand in the Seminole area.

Production Methods

Very early in the history of development gas-lift practice was introduced into the pools of the Seminole area. The fundamentals of this method of lifting had long been known but the refinements of today were entirely lacking. Before the practice of gas-lift had reached its peak many millions of dollars had been invested in the necessary equipment and most of this equipment had a major part of its physical life still remaining when it was abandoned. It is not desired herein to go into a detailed discussion of the probable merits or demerits of gas-lift as applied in this area, for that subject still is highly debatable. It may be of interest, however, to present the productive history of two leases in the Seminole City pool wherein there seems to have been evolved some evidence in this connection. Carter Oil Company's Mary Killingsworth lease, comprising the N½ of the NW and the SE NW of section 23-9n-6e, 120 acres, is situated on the northwest side of the structural axis within a few locations of the northwest edge of production. This lease had an average Wilcox sand penetration of about 34 ft. in the 13 wells that were drilled, one of these being a five-spot well drilled after the lease had been producing for several years. It was gas-lifted to capacity for a long time and many of the wells that had settled to several thousand barrels below their initial daily rates were boosted back up, in some cases to rates greater than their initial. This lease is estimated to have produced 11,395,000 bbl. of oil as of July 16, 1941, from 120 acres, an average of 94,958 bbl. an acre and an average of 2793 bbl. per acre-foot of penetration. The 60 acres offsetting the Mary Killingsworth to the west and lying along the west edge of production, have produced an estimated 3,160,000 bbl. or 52,666 bbl. an acre. The 80 acres offsetting the Killingsworth to the east, lying much higher on structure, have produced an estimated 2,782,000 bbl. or 34,775 bbl. an acre. It appears from this condition that gas-lift on the Killingsworth lease did not cause premature abandonment of any of the offset leases and that it has resulted in a greater recovery than would have been obtained without gas-lift. Some of the offset and nearby leases either did not have gas-lift applied or it was applied for a comparatively shorter time than on the Killingsworth.

Another instance that serves to complicate the problem of determining the probable effect of gas-lift is that of the Pure Oil Company's Strothers lease, SW 26-9n-6e, about one mile south of the Killingsworth lease and possibly situated slightly more favorably on structure. This lease is estimated to have produced 14,660,000 bbl. from 160 acres with an average penetration of about 40 ft. This is a per-acre recovery of 91,625 bbl. and a per acre-foot recovery of 2291 bbl. The Strothers was gas-lifted only for a very relatively short time and the operator resorted to pumping long before some of the surrounding leases had abandoned gas-lift. Yet it has outperformed any of its offsets. From the standpoint of total recovery to date it is the largest lease in the entire district. The last date for which production figures are available from the Seminole pool is for January, 1941, during which month the Strothers lease was producing at the average rate of 1307 bbl. a day from 14 wells, a daily well average of 93 bbl. During that same month the Killingsworth lease was producing at the average rate of 438 bbl. a day from six wells, a per well average of 73 bbl. This may indicate that ultimately the Strothers lease will produce as much per acre and as much per acre-foot as will the Killingsworth.

EDITOR'S NOTE: This article will be continued in an early issue of *The Petroleum Engineer*.

TABLE 2

Pool	Wilcox discovery well	Location	Depth, ft.	Initial production	Date of completion
Allen	Sinclair-Prairie, Amos "B" No. 2	SE NE SW 7–5–8	4160-4175	1815 bbl. flow	1–21–29
Bowlegs	I. T. I. O., Davis No. 1	SW SW SW 13–8–6	4194-4200	5500 bbl. flow	1–4–27
Earlsboro	Gulf, State No. 1	NE NE NE 16–9–5	4275-4291	8050 bbl. flow	12–3–26
Earlsboro, Ext.	Pierce et al, Phillips No. 1	SW SW SE 8–9–6	4240-4245	230 bbl pump	4–5–31
Earlsboro, S.	Amerada, Grounds No. 1	SE NE NE 22–9–5	4188-4214	8170 bbl. gas	4–3–30
Little River	I. T. I. O., M. A. House No. 1	NW NW NW 1–7–6	4017-4028	13,541 bbl. flow	7–1–27
Little River, E.	Mid-Continent, Smith No. 1	NW NW NE 5–7–7	4425-4447	3655 bbl. flow	10–9–28
Mission	Gulf, Mission No. 1	SW SW SW 5–8–6	4327-4340	3210 bbl. flow	6–11–28
Sasakwa	Sinclair-Prairie, I. Davis No. 1	NW SW SE 7–6–8	4100-4164	957 bbl. flow	Apr., 1929
Searight	Searight Oil Co., Youngblood No. 3	NW NE SE 33–10–6	4315-4317	4572 bbl. flow	10–11–26
Seminole	Amerada, Jones No. 1	NE SE 21–9–6	4258-4277	60 bbl. flow	7–10–26
Seminole, W.	Amerada-Dixie, Chase No. 1	NW NE SW 29–9–6	4087-4116	2500 bbl. flow	Aug., 1930
St. Louis	Magnolia, J. J. Harper No. 1	NE NE NE 19–7–5	4088-4093	351 bbl. flow	7–20–27

TABLE 1

Discovery wells in pools of Greater Seminole Area

Pools	Discovery wells	Producing horizons	Total depth, ft.	Date completed	1940 production, bbl.	Estimated recovery as of 7-16-41, bbl.	No. of producing acres	Estimated recovery per acre, bbl.
Allen	Arkansas Fuel, McElroy No. 1	Cromwell	2465	7–25–27	1,898,401	50,487,612	3,000	16,829
Asher, West	Payne Drilling Co., Bullock No. 1	Wanette	3513	4–16–30	Est. 120,000	7,440,401	700	10,629
Bowlegs	I. T. I. O., Goforth No. 1	Calvin	2443	6–18–26	2,462,064	117,974,858	3,600	32,771
Carr City	Barnsdall, D. Fife No. 1	Wilcox	4296	12–11–27	839,646	30,229,224	1,160	26,060
Earlsboro (a)	Morgan-Flynn, Ingram No. 1	Earlsboro	3580	3–1–26	1,577,494	130,737,659	4,750	27,524
Earlsboro (b)	Magnolia, Anderson No. 1	Wilcox	4298	1–6–29	1,302,958	60,105,685	2,300	26,133
Konawa	Konawa Operating Co., Harjoche No. 1	Cromwell	2910	11–19–29	394,959	15,092,406	1,200	12,577
Little River (c)	Cities Service, Sandlin No. 1	Earlsboro?	3663	10–?–26	2,647,398	127,779,852	5,100	25,055
Maud	I. T. I. O., School Land No. 1	Simpson	4290	1–19–28	201,319	11,588,096	1,520	7,624
Mission	Josaline, Melisse No. 1	Simpson?	?	11–?–27	459,551	25,136,177	1,250	20,109
Sasakwa	Pittsburg P. & S., Phillips No. 1	Simpson ?	4181	3–?–28	432,047	9,821,927	680	14,444
Sasakwa Townsite	Stanolind, Palmer No. 1	Wilcox	4051	4–6–33	129,341	2,289,954	120	19,083
Searight (d)	F. J. Searight, Youngblood No. 1-A	Hunton	4157	4–21–26	728,143	37,331,343	1,650	22,625
Seminole (e)	I. T. I. O., James No. 1	Hunton	4012	3–7–26	2,948,013	135,383,046	5,150	26,288
St. Louis (f)	Magnolia, F. Vieux No. 1	Simpson	4290	4–1–26	9,406,793	143,347,278	7,800	18,378
					25,548,136	904,745,518	39,980	22,630

(a) Including Earlsboro Townsite. (b) Including Earlsboro, South, East and East Extension. (c) Including East Little River. (d) Including North Searight. (e) Including East Seminole. (f) Including Pearson.

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WHEN the search for oil takes men and machines to steep mountain slopes like this, the performance of International Diesel TracTracTors soon shows up in reduced costs and time saved. Engine horsepower and sure-footed traction work together. First thing you know, you're through on schedule, another rig site ready. That's what happens when International TracTracTors take charge. You get that kind of performance because these tractors are built right in the first place—and because they are backed by International Harvester's long record of *quality* tractor manufacture.

Put International *full Diesel* TracTracTors in charge wherever you have rig and derrick sites to clear, roads to build, slush pits to dig, pipe lines to lay. Four sizes—TD-6, TD-9, TD-14, TD-18. Get the benefit of these features: quick, easy starting; Tocco-hardened crankshafts; replaceable cylinder sleeves; fast, easy gear shifting; wide speed range; full-pressure engine lubrication; and many others. The nearest International Industrial Power dealer or Company-owned branch is at your service. Ask for a demonstration.

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View shows an International TD-18 TracTracTor, equipped with cable-operated bullgrader, carving a rig site north of Ventura, Calif. This outfit is owned by Chanslor Canfield Midway Oil Co., Los Angeles.

INTERNATIONAL Industrial Power

P 425.218.4
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Mud testing cabinets of the type shown at extreme left are kept at the well by many operators to maintain condition of the drilling mud

Exclusive

by
Wallace A. Sawdon
Pacific Coast and Foreign Editor

Well Completions Improved by Concentration of Prepared Bentonite in Drilling-in Fluid

☆ Formation of easily removed filter cake on face of sand desirable to prevent water loss from drilling mud

AMONG wells in a certain area, some will swab to production and clean-up readily with relatively high production; others will require a greater period of time in which to complete and often will fall short of anticipated potential production. One factor that probably contributes greatly to this difference is the extent of the infiltration of water from the drilling mud into the oil-bearing formations as the degree to which the sand, due to its permeability, permits the flow of oil into the bore is reduced by water encroachment. Drilling muds that have a high water loss are detrimental to oil sands and not only make the operation of bringing-in the well more difficult and lengthy but may adversely affect the potential production.

Formation of an effective but easily removed filter cake on the face of a productive sand while drilling-in is, therefore, particularly desirable when completing a well in a low-pressure zone; but the exclusion of water infiltration to the greatest extent possible will have beneficial effects on the immediate, and sometimes permanent, passage of oil into the hole even in wells where some weight must be carried to offset formation pressure. Recent practices established by some of the companies in a number of fields in California as well as in many other districts throughout the United States indicate the advantage of changing the mud before entering the sand. This drilling-in mud in many cases consists entirely of prepared bentonite and water and in others (where a little more weight is necessary) of well-conditioned mud fluid to which sufficient prepared bentonite is added after proper thinning to allow for the high concentration of the bentonite.

Object of Changing Fluid

The object of changing the drilling fluid when drilling through the sand is to obtain a mud that will deposit a cake on the face of the sand that will not only prevent water loss while drilling but will be so thin, soft, and easy to remove that no washing will be necessary. The fluid composed entirely of prepared bentonite and water not only possesses these properties in the highest degree but also provides the viscosity and gel-strength necessary to bring up cuttings and hold them in suspension in the event circulation is stopped. For use when drilling low-pressure sands, such a fluid has the advantage of low weight and, due to its extreme colloidal properties, will have a tendency to prevent loss of circulation into very porous or fractured sand.

In considering the several characteristics of a bentonite-water fluid there are other properties that are of importance in varying degrees dependent on the down-hole conditions. Such a fluid will be devoid of corrosive tendencies that might accompany certain clays. The salt content of many native clays may even have an effect on the electrical log although the infiltration of water when using muds allowing high water loss may also affect the log. The lubricating qualities of the bentonite-

PETROLEUM ENGINEER EDITION

BAASH-ROSS News

A MONTHLY BULLETIN COVERING NEWS OF EQUIPMENT AND OPERATIONS IN THE PETROLEUM INDUSTRY

WORLD'S RECORD FISHING JOB PROVES DEPENDABILITY OF B-R EQUIPMENT

Baash-Ross Cutter Breaks Own Record Six Successive Times

Most oil men know that the world's deepest *drilling* record is down around 15,000 feet (15,004 to be exact). And quite a few can come close to telling you the depth of the world's deepest *producing* well—13,266 ft. But ask about the world's deepest *cut-and-pull* job and 9 times out of 10 the average oil man is several thousand feet short of the mark. Why?

Well, for one thing most every oil man knows that, even at best, a cut-and-pull job is no picnic. And other things being equal, he also knows that the deeper the job the more complications there are to upset the applecart. There's more stretch in the drill pipe to contend with when operating the tools. There are considerably higher bottom-hole temperatures and pressures to consider (factors which might affect the operation of some tools). There's more pipe exposed in the open hole while operations are going on. And, of course, each trip into and out of the hole takes longer and becomes more and more costly as the depth increases.

But it's significant to note that the world's deepest cutting job exceeds by over a THOUSAND feet the depth of the world's deepest *producing* well. *And the cutting tool with which this phenomenal record was made is the Baash-Ross External Drill Pipe Cutter!*

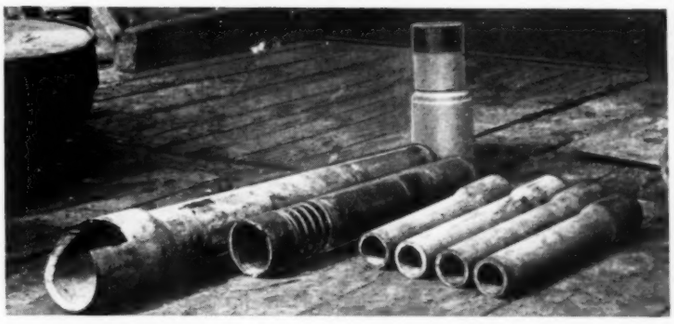
The depth? 14,366 ft.!

In all the history of the oil industry, only *twice* has even a drilling bit exceeded that depth and then, *at the most*, by only some six hundred feet. Fluid pressure at that depth runs around 8000 pounds per square inch and the "working" stretch in 3½" drill pipe averages about *fourteen* feet!

But the thing we think most remarkable about this record is that it was not a spectacular "one-shot" try where everything is keyed up to a do-or-die attempt. Rather, it was the final cut in a routine series of SIX successful cuts... *each of which set a new world's record in itself.* Such methodical consistency proves beyond question that the Baash-Ross External Pipe Cutter is a tool you can depend upon in *any* emergency.

NO SEPARATE OVERSHOT WAS USED in removing this pipe, because the Baash-Ross External Drill Pipe Cutter not only cuts the pipe but also is its own overshot, supporting the cut-off section while it is removed from the well. Thus, the cutting and removing operations are performed on one trip without wasted time, for as soon as the cut is completed, the tool and cut section are ready to be withdrawn from the hole.

Another important feature in this tool is that each cut is automatically spaced a short distance below a tool joint or collar. This insures *every* cut being made on the pipe only—not on the thicker collars or joints.



YOU'RE LOOKING at four world's record cuts... and the Baash-Ross External Pipe Cutter with which they were made. These are the first four of the six cuts made. Note the smoothness of the cuts and the uniformity with which all cuts were made—each one at exactly the same place on the joint.

Here, cut by-cut, is the record of the amount of pipe removed and the depth at which each cut was made. Note that even the first cut—made below 12,600 feet—set a new world's record . . and this was only the beginning. Note also the uniformity of the 5 main cuts—one of 11, one of 13, two of 14 and one of 15 joints. And the bottom cut—the one of 4 joints—so completely removed all of the pipe above the drill collar that even the tool joint was cut off from the last joint of the pipe in the hole!

AMOUNT OF PIPE REMOVED AT EACH CUT

Cutting Depth	Joints Removed	Feet of Pipe
12,676	15	452
13,011	11	335
13,402	13	391
13,822	14	420
14,244	14	422
14,366	4	122

▶ WHAT DOES THIS RECORD MEAN TO YOU? Just this—*regardless of the depth*, a cut-and-pull job is *one* place you can't afford to take chances. The Baash-Ross External Drill Pipe Cutter is the *only* cutting tool to have proved its unfailing dependability at every depth *right down to the deepest*. So in *any* emergency—in *any* well—this tool is your safest bet for a quick, efficient outside cutting job!

The Baash-Ross External Cutter is available for use with (1) Collared pipe, (2) Upset pipe and (3) Flush Joint pipe. Complete information on its many outstanding features is available from your nearest Baash-Ross representative.

(Leased in U.S.A.—Sold for export only)

ON THE LOOKOUT

WITH THE SUPPLY of aluminum paint reduced, chemists have been quick to develop a satisfactory substitute for painting crude oil storage tanks. The tanks of at least one well-known refinery have already been covered with this new paint, which reflects light and heat—and withstands climatic conditions—as effectively as the aluminum product, according to reports. (No. B-81)

BAASH-ROSS

IN THIS COLUMN, we recently reported how numerous "mystery" explosions had been traced to body electricity which sparked when workers touched metallic objects, thus igniting explosive atmospheres. That report spotlighted development of safety shoes which conducted static electricity out of the wearer's body. An even newer development along this line is a fiber safety wheel for hand trucks, etc. The fiber, of course, will not spark like metal does when it strikes a hard object . . . and, in addition, the wheel incorporates a unique copper core that instantly grounds all static electricity from the truck or load. Should be of interest to oil operators wherever explosive conditions exist. (No. B-82)

BAASH-ROSS

IT IS AN ESTABLISHED FACT that the suction created when gun perforators are fired is strong enough to pull dust, rock fragments and sometimes even the bullet itself back into the shell from the formation. A recent paper suggests a method of using this phenomenon to advantage—for formation logging. Tests were made in which the formation fragments were removed from the shell at the surface and microscopically examined against known markers. Little trouble is said to be encountered in isolating the fragments and the tests demonstrated that the material in the shell is always from a point directly opposite the perforation. Describes procedure and method of using this data. (No. B-83)

BAASH-ROSS

NYLON HOSE, NYLON TOOTHBRUSHES—and now the newest development is a Nylon machinery bearing to replace ordinary bronze or brass bearings. It reduces friction of rotating shafts... will handle loads heavier than regular bronze or brass bearings... and, according to reports, *requires no lubrication*—not even water. This may be the "bearing of the future" on many items of oil field equipment. (No. B-84)

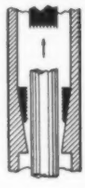
For more details, simply send your name, address and key numbers of items that interest you on a post card or letterhead.

YOU HAVE TO HOOK 'EM BEFORE YOU LAND 'EM

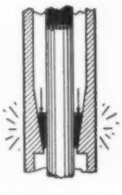
You fishermen all know that there wouldn't be so many stories about "the one that got away" if more fish were hooked so they *stayed* hooked. And the same holds true for oilwell fishing... only here a lost fish is mighty serious business.

You can't expect to come out on top of a man-sized fishing job when you have only a weak-kneed, *partial* grip on the fish. So, BAASH-ROSS developed the *"Type B" Rotary Releasing Socket* to incorporate a unique safeguard that insures a uniform *full-length* grip every time.

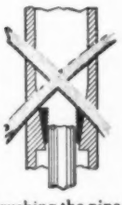
Here's How It Works:



As the Baash-Ross Socket descends over the top of the fish, there are no friction springs or dragging slips to interfere. Instead, the slips remain fully retracted until the top of the fish is *completely into the socket.*



When completely in, the fish contacts the sharp-toothed face of the slip holder and—by holding this part against rotation—permits the slips to be released. Then, as the tool is lifted slightly, the slips are automatically forced into gripping contact by the pressure of a coil spring.



This important operating safeguard insures easier entrance of the fish... and practically eliminates all chance catching the fish with only a partial grip.

Furthermore, it insures a full-length grip taken *below* the top of the fish where danger of crushing the pipe is far less than at the top.

This is why the Baash-Ross Socket will withstand hour after hour of severe jarring without losing its grip or deforming the fish.

Quick release can be effected by simply reversing the operation... and the slips may be repeatedly set and released as often as desired without removing the tool from the hole.

This "Type B" Socket is just one of the many *engineered* fishing tools Baash-Ross has available for every type of fishing problem. So bring your fishing troubles to us, and you'll land more fish... *quicker!*

(The Baash-Ross Socket is leased in the U.S.A.—Sold for export only.)

How About DIE COLLARS?

Need some? We've got 'em... made of special steel, heat-treated so they're *hard* at the threads for quickly cutting a "hold" on the fish... and *tougher* than hog gristle on the inside so you can p-u-l-l your heart out without breaking them! Plain or Drag-Tooth... All Sizes... AMPLE STOCK. Just call Baash-Ross!

Testing filter cake building properties is sometimes done with test car equipment

water mixture are, of course, very high and will reduce the wear on bits and equipment handling the fluid. The lubricating qualities, plus the thin mud cake formed, facilitate the running of casing and liners, particularly when clearances are small. This fluid, being almost entirely gel-forming colloidal material, readily yields to chemical treatment; and, probably due to the fact that it contains no soluble salts that leach out to cause flocculation, gives a minimum increase of cake thickness in the presence of high temperatures.

Where drilling-in requires weight to some extent the prepared bentonite can be concentrated in the fluid to give the desired qualities and weight material added to provide the necessary weight. Though this discussion is confined to the fluid used for drilling through the oil producing zone or zones, there are instances in which the circulating fluid used for drilling the entire well has been composed of prepared bentonite and water, weight being added if and when formation pressures have to be overcome. The use of prepared bentonite for drilling-in at several fields, however, will show applications under different conditions.

Applications in Various Fields

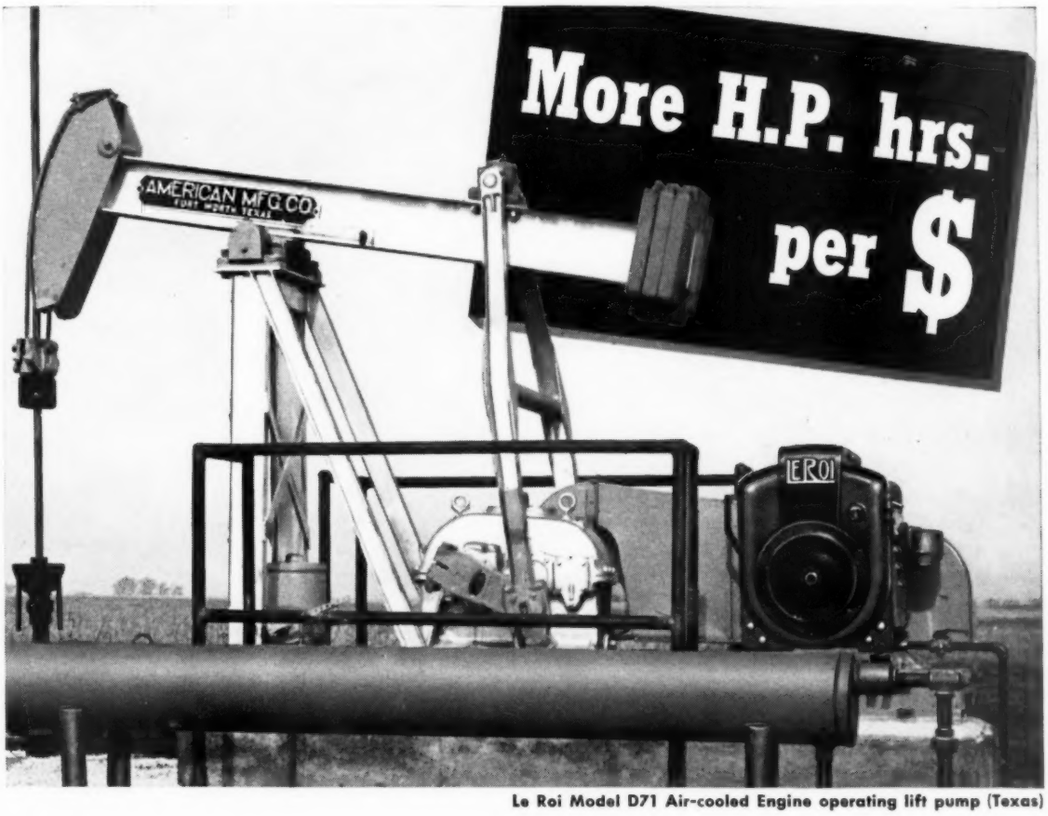
At one field the wells are drilled to the top of the oil sand with ordinary, low water-loss muds that are conditioned throughout the drilling. The total depth of wells range from 9,000 to nearly 10,000 ft. but penetration through the oil sands varies from approximately 200 to 500 ft., that of some wells even more. As soon as the top of the sand is reached the casing is set and the cement drilled-out with the mud used in drilling the hole. Five feet of hole being drilled below the shoe, a water shut-off test is then made. After the shut-off test has proved the cement job to be satisfactory the old mud is replaced by fluid composed entirely of prepared bentonite and water and the hole drilled through the sands to the desired depth with this fluid. An electric log is then taken and a liner with perforations opposite each productive zone set in place. Tubing is run to the top of the oil sands and the drilling fluid replaced with water to this point. The well is then swabbed until it flows.

In this field, it has been the practice to mix the prepared bentonite and water during the time the casing stood cemented. The fluid was mixed in the usual way by using a cone and jet mixer. The mixed mud was then allowed to stand in a tank for several days so that complete hydration took place. About 20 sacks of bentonite were used to make 100 bbl. of mud of viscosity of about 35 seconds. The water-loss varied from 18 to 26 ml. in an hour, and the weight was 66 lb. per cu. ft. After the mud was placed in the hole, the viscosity was raised to 40 seconds by the addition of more bentonite. No thinning chemicals were added to the mud due to the fact that it was desired to have a thin, fluffy cake rather than a gummy one. It is thought that the gummy, sticky filter cake is harder to remove from the walls of the hole and is harder to get through the slots of the liner than the fluffy, soft, untreated mud cake.

A new procedure has been used on the last well drilled in this field. The bentonite-water fluid used in drilling a previous well was treated with additional bentonite to bring the viscosity up to the desired value, and this mud used to drill the second well. It required about 70 sacks of bentonite to recondition the old mud.

The procedure being followed in another field is very similar to that described above. The total well depths range from 8000 to 8500 ft. and in the recent wells the penetration through the deep zones varies from 300 to 600 ft. Casing is set on top of the productive zones, the cement is drilled-out and, after testing, the mud used to drill to the casing point is replaced with a bentonite-water fluid for drilling through the sands.

In this field loss of circulation is a problem encountered in the first 50 ft. of sand, so it is desirable to maintain a low weight and high viscosity. Approximately 23 sacks of prepared bentonite are used to make 100 bbl. of drilling fluid, the mixing being done with a regular cone and jet mixer. The fluid is allowed to hydrate for several days before being put into the hole. The resulting viscosity is approximately 50 seconds (500 cc. in and 500 cc. out with Marsh funnel) and the weight 67 lb. per cu. ft. No thinning chemicals are added during drilling. As soon as the total depth has been reached an electric log is taken. The liner is then set, the drilling fluid



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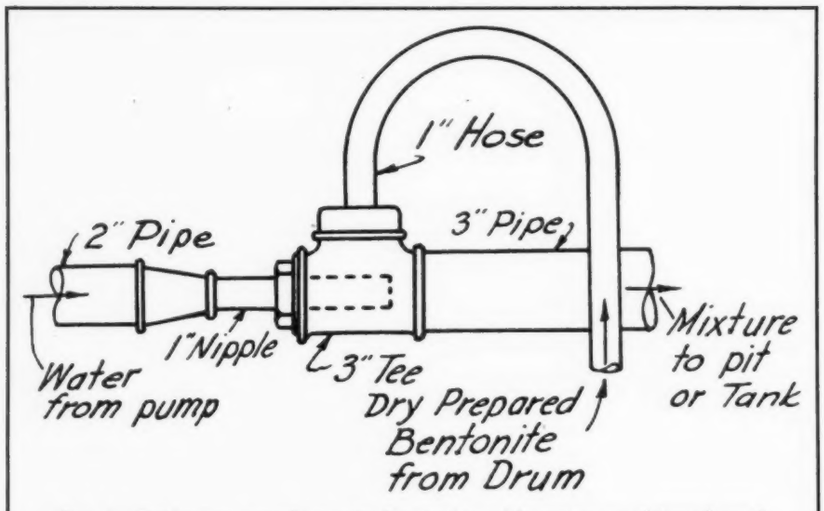

Fig. 1. Equipment used to mix bentonite with water or thinned mud

replaced by oil, and the well swabbed-in.

A different procedure is being followed in one field where the total depth of wells is about 11,400 ft. and penetration through the sand varies from 100 to 300 ft. As soon as the casing has been run, the cement drilled-out and the shoe tested, the old mud in the hole is thinned down with water to approximately 70 lb. per cu. ft. Prepared bentonite is added to this mud to bring the viscosity to 45 seconds. This fluid is then used to complete the well. After running liner and tubing the mud is replaced with either oil or water—depending on the operator—and the well brought in with gas. It is necessary to use a slightly heavier drilling fluid in this field than in the ones previously discussed, so the 70-lb. base mud is employed. Thinning chemicals are introduced in this mud to obtain suitably low water-losses of from 10 to 15 ml. in an hour at the desired viscosities.

The procedure at another deep field employs the use of a mud of 72-lb. per cu. ft. that is treated with the prepared bentonite to obtain a viscosity of 45 seconds. This mud is, in turn, weighted to 75 lb. by the addition of weight material. The object is to obtain a low water-loss fluid of suitable weight without excessive solid content. The required viscosity of the fluid while drilling through the productive zone is maintained by the use of chemicals as the bottom-hole temperature is greater than in any of the fields previously cited.

It is the opinion of the operators that the use of the concentrated prepared bentonite in the fluids being employed to drill through the productive zones in these fields has aided in getting better wells. It appears that wells completed by this procedure have cleaned-up more quickly and have produced more oil and gas than other wells in the same areas that were drilled through the sands with heavier, native-clay muds.

Thorough Mixing Essential

The thorough mixing of the bentonite with the water or with the thinned mud is an important factor. The best type of mixer at present seems to be a modification of the regular cone and jet equipment. This mixer is made by removing the cone and replacing it with a bushing to which is attached a 1-in. hose as shown in Fig. 1. As the water is pumped through the jet it causes a vacuum and this vacuum sucks the dry bentonite through the hose, the end of which is placed in a supply usually contained in a 50-gal. drum or similar receptacle. This permits feeding the bentonite into the stream of water at any desired rate and prevents "balling-up" of the material. The mixture usually goes to a pit or sump and is frequently circulated several times before being pumped to a mud storage tank or into the circulation system of the well.

P 425.218.1

Effective Method For Adjusting Suction Line in Mud Pit

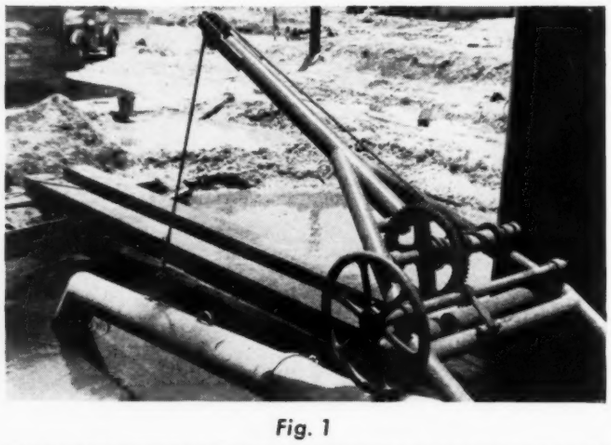

Fig. 1

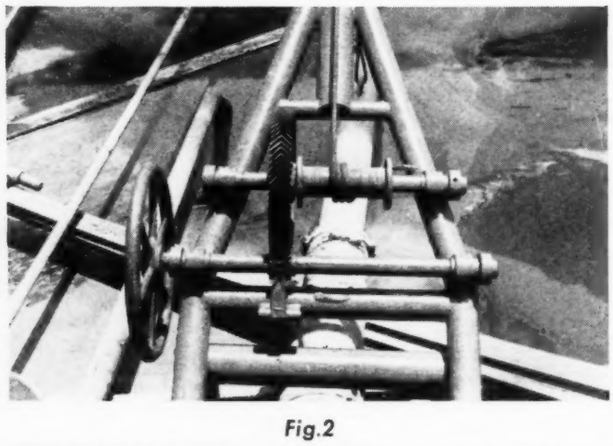

Fig.2

VARIOUS devices for raising and lowering the pump suction lines in mud pits have been devised. Some of these have been quite satisfactory, but often considerable effort is required to operate the devices.

The accompanying photographs show an effective method whereby the line may easily be raised or lowered.

Fig. 1 shows the method of fabricating the hoist-and Fig. 2 is a close-up showing the arrangement of the gears.

The two gears may be of any suitable ratio. Obviously the smaller the driving gear and the larger the driven gear, the more powerful the hoist will be.

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Globe non-tracking Two-Way Cutters operate in perfect free-running alignment at all times despite heavy loads and severe twisting strains. This is assured by the Globe one-piece body with an integral 5th leg (Fig. 1), a center support which braces gauge and inner cutters and extends their capacity to withstand stress and strain.

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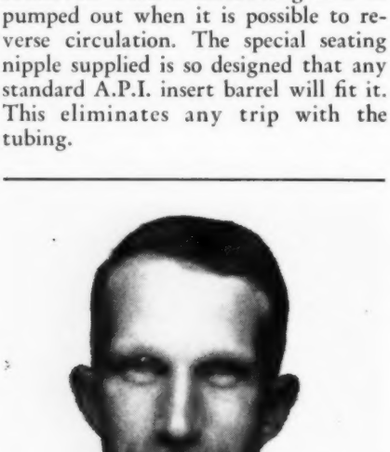
Removable Type Hydraulic Jet Gun Used in Acidizing

PETROLEUM ENGINEER Exclusive Feature

☆ Equipment dropped in tubing, seating on special nipple — Removal is by means of measuring line or by pumping out with reverse circulation

by C. A. Pitts, District Engineer
and
C. F. Seeber, Acid Field Engineer
Halliburton Oil Well Cementing Company

HYDRAULIC guns of many different designs have been used for treating wells with acid. Most of these have been attached to the tubing, thus making it necessary to make a round trip with the tubing to recover the gun at the end of the treatment. To eliminate this, a gun has been devised that may be dropped in the tubing and caused to seat on a special seating nipple. This gun is retrievable by one of two methods. It can either be retrieved with a measuring line or pumped out when it is possible to reverse circulation. The special seating nipple supplied is so designed that any standard A.P.I. insert barrel will fit it. This eliminates any trip with the tubing.



C. A. PITTS

worked in various Wyoming oil fields before entering the University of Kansas in 1932—After graduation in 1937 he was employed by the Continental Oil Company as a mud engineer on heaving shale wells being drilled in the Gulf Coast of Texas—Upon completion of this work was employed by various drilling contractors in the Gulf Coast area—Joined the Halliburton organization in 1939—Has been district engineer for the Louisiana Gulf Coast district since April, 1941.

Advantages of Gun

The advantages of this removable type gun are many. Cementing off bottom of wells through tubing and subsequently jetting out the excess cement above the pay zone without removal of the tubing from the hole is becoming a standard practice in some areas. Furthermore, by simply changing the tip on the jet gun it is possible to accomplish any type of jetting job in minimum time and at minimum expense to the operator.

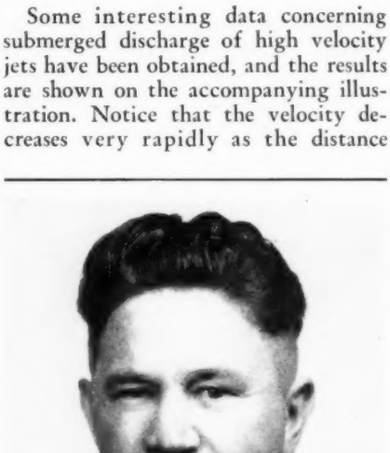
Research Work

In view of the rapidly increasing number of applications of this removable type gun, some research work has been done in order to determine the limitations governing its use. Obviously the only purpose that a jet gun can have is to create turbulence at a desired point. The turbulence does work directly in proportion to the kinetic energy developed at the face of the orifice. In order to determine the fundamental hydraulic principles governing this turbulence, it was necessary first to determine the most efficient type of orifice. This was done by using different designs of orifices with different cross-sectional areas operated at pump pressures ranging from 250 lb. to 2000 lb. per sq. in. The amount of fluid pumped through a given orifice in a given time was measured and from these data the exact velocity was determined. The exact velocity compared to the ideal theoretical velocity as expressed in the equation $V = \sqrt{2gh}$ gave a discharge coefficient of 0.976 for the jets now being used.

With the type of orifice best suited to this work, the pressure and the size of the orifice that should be used can be determined. The factors limiting the size of orifice depend so much on the velocity of the jet stream that these two conditions cannot be separated. As the kinetic energy of a jet depends on the size of the jet as well as the velocity, it appears that the larger the jet the more work can be done. This was found to be true. The only limitations governing the size of the jet are the amount of acid to be used in jetting and the time that is to be spent jetting. If it is possible to re-circulate acid in jetting, these factors are eliminated.

Data on Submerged Discharge

Some interesting data concerning submerged discharge of high velocity jets have been obtained, and the results are shown on the accompanying illustration. Notice that the velocity decreases very rapidly as the distance



C. F. SEEBER

was born in Great Bend, Kansas, in 1896—Studied chemical engineering at Kansas State College, 1913-17—For a time was a chemist with the Larabee Flour Mills—Took an active part in the first World War, after which he was employed by the Stanolind Crude Oil Purchasing Company—Was a member of the Atlantic Refining Company's staff from 1932 to 1936—The latter year he joined the Halliburton Oil Well Cementing Company—Is a field representative of the company making his headquarters at Wichita, Kansas.

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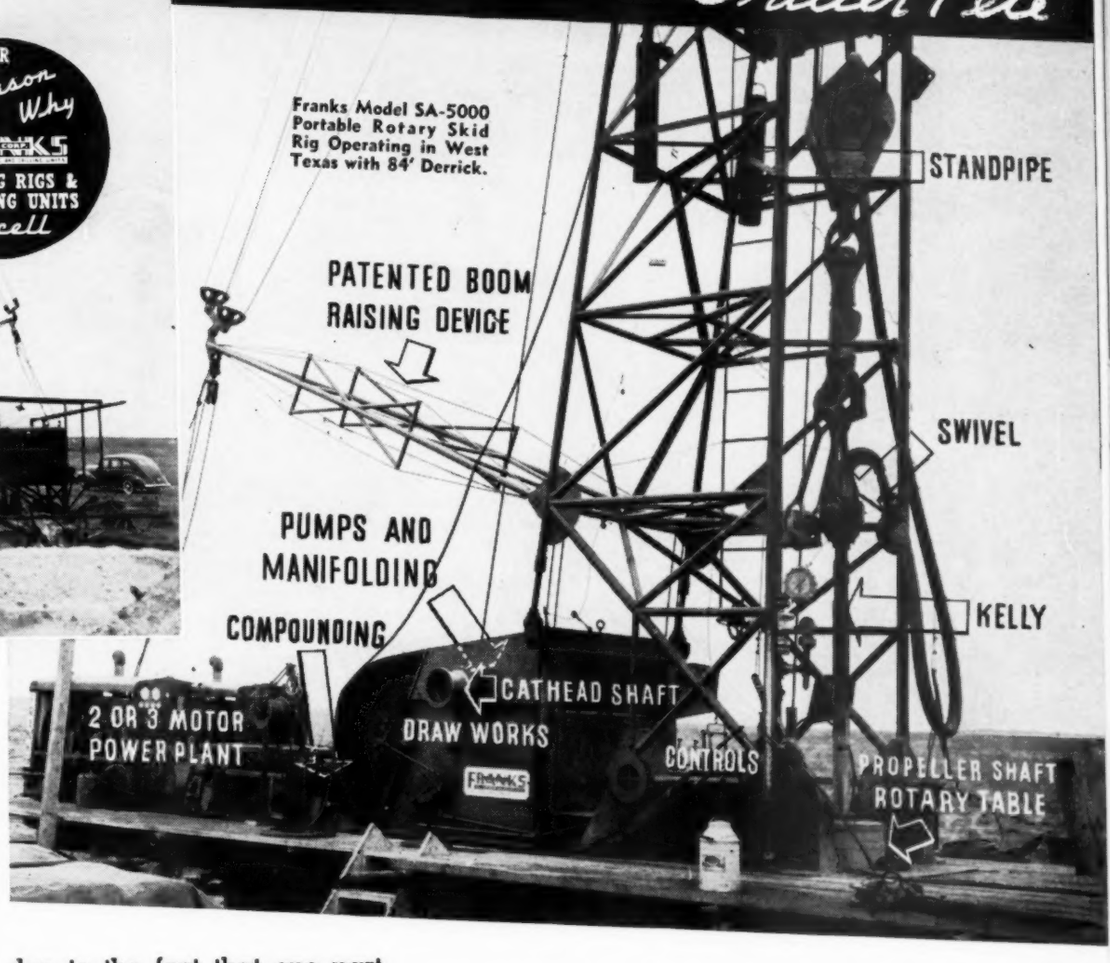

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An automobile with one make engine, another make body, another make transmission, etc., might have the finest parts in the world, but the maximum in fuel economy, long life, repairless wear, and satisfactory operation would be lacking. If the motor was too heavy for the body, the body would soon be worn out. If the motor was too big for the transmission, either the maximum power could not be used or the transmission would soon be torn to pieces.

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Drilling unit made in two sections: (1) power plant and (2) drawworks, which are easily and quickly assembled and disassembled. No controls or other vital parts to connect or disconnect. The unit may be moved in one piece for short distances. Derrick may be moved in one piece for short distances or quickly and easily unjointed in two or three sections for longer moves. Unit can be rigged-up and drilling started within three to four hours after reaching location.

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Acid jet guns; 2-in. and 3-in. sizes with seating nipples

from the orifice increases. The effective range of a jet as a cutting medium is greatly affected by the distance. By experiment, the theory governing the cutting action of a jet has been established.

When cement is drilled with water as a jetting medium, it is found that the cement is broken into small pieces, indicating that jet drilling is a result of jet impact. As the force of a jet of fluid gives steady pressure rather than a sharp blow, it is impossible to think of a jet drilling in any other way than by exerting enough pressure to crack the material being drilled.

If it could be assumed that a jet dissipated all its energy at the face of the material being drilled, a drilling ratio between the kinetic energy in the jet and the compressive strength of the material being drilled could be established. Unfortunately, however, the jet stream suffers only a change in direction, which is expressed by the following equation:

$Px = 2.01\ AV^2(1 - \cos \Theta)$ for 7 percent acid.

Where Px = Total pressure resulting from deflection of jet.

2.01 = Constant for 7 percent hydrochloric acid.

Water = 1.94.

A = Area of jet.

V = Velocity.

Θ = Angle of deflection.

From this equation one might think the size of the jet would not make much difference. Assume that a circle 1 in. in diameter was to be covered by a jet. The ⅛-in. jet would have to travel almost 6 in. before it would cover this circle. The ¼-in. jet would have to travel only 3½ in. before it would cover this circle. The ⅛-in. jet at the 1-in. circle would have a velocity of only 17 percent of its original velocity, whereas the ¼-in. jet would have 32 percent of its original velocity. According to these facts, the area affected by the turbulence created by jets depends more on the size of the jet orifice than on any other factor.

When a jet is used horizontally against the pay formation, the angle of deflection of the jet may be thought of as 90 deg., in which case the cos Θ is 0. Once a small hole is drilled into the formation, the fluid in the jet stream is reversed in direction, thus increasing the angle Θ from 90 deg. to 180 deg., which changes the cos Θ from 0 to —1. The corresponding effectiveness then depends on the relative amount of change in direction of the jet stream. This in itself is turbulence.

These considerations all have been made with the idea that the only action of a jet was the crushing effect, which is limited by the distance from the orifice as well as the compressive strength of the material being jetted. The jet operated at 1000-lb. pressure against material with 6000-lb. compressive strength will have a crushing effect 5.2 in. into the material being drilled. This depth of penetration does not depend upon the size of the jet. The rate at which drilling is done, however, depends on the size of the jet for several reasons other than the crushing effect.

When a pay is jetted horizontally, the forces set-up are three:

(1) There is a violent turbulence set-up in the immediate horizontal plane of the jet.

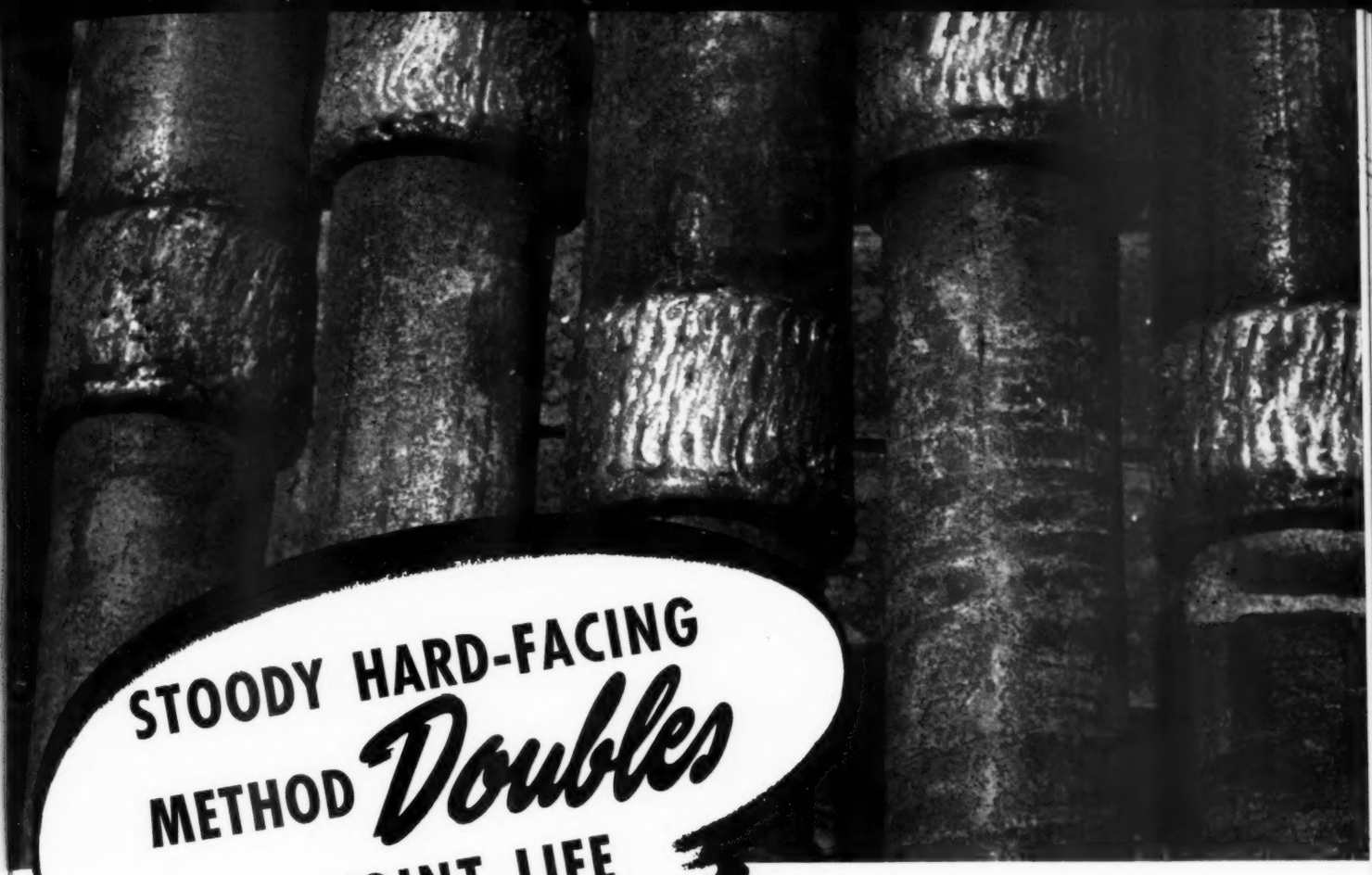
(2) There is an upward component that causes the fluid to return to the surface through the annulus between tubing and casing.

(3) There is a downward pressure that is equal to the upward component.

The turbulence created in the hole must be thought of as being most vioent in the immediate horizontal plane of the jet. Intensity of this turbulence depends upon the kinetic energy being created by the jet. As jetting jobs are done with the casinghead open to permit free circulation, the only conversion from velocity head to pressure head is the small amount that is necessary to raise the jetting fluid to the surface. The rest of the velocity head must create turbulence so violent that its energy is dissipated into heat. If a ¼-in. jet is operated at 1000-lb. differential, the amount of heat generated is 23 B.t.u.'s per sec.

In most formations, particularly cement and cement-coated formations, there is a strong tendency for reaction products to cover the surface of the formation of the material and thus slow down or prohibit further chemical action. This surface deposit is more or less gelatinous in character and is easily removed by fluid turbulence. Thus it may be seen that the turbulence created in jetting continuously cleans away the reaction products, leaving a clean surface for further chemical reaction.

From the above-mentioned factors two conclusions may be drawn. First, the amount of work done is directly proportional to the energy spent at any point. The more nearly one can approach the placement of energy at a given point, the more efficiently can work be accomplished. By placing all

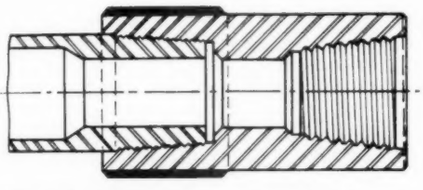


STOODY HARD-FACING METHOD *Doubles* TOOL JOINT LIFE

For years, oil operators have been faced with the problem of tool joint wear—a problem even more serious today because of increased drilling depths . . . higher penetration rates . . faster rotating speeds . . . and open hole drilling operations. These factors take their toll in rapid tool joint wear, which not only dangerously weakens the pipe connections *but also increases drilling and maintenance costs!*

But now it is possible to actually *double* tool joint life under even the toughest drilling conditions by applying Stoody Hard-Facing Alloys direct to the wearing surfaces of these tool joints. Not only is wear greatly reduced, but correct elevator contour is maintained—an important safety point!

Electric Tube Borium or Coated Stoody Self-Hardening is used for this application. The coating can be applied either over the regular tool joint surface or inlaid into it to eliminate over-gauge joints—whichever is preferred. Either way, you'll make substantial savings with this new Stoody application!



Schematic drawing illustrating method used in Mid-Continent for hard-facing tool joint boxes. Coated Stoody Self-Hardening is applied directly to the surface of the collars, no recess being machined into them. After heating joints to approximately 300° F. the hard metal is deposited to a thickness of from 1/8" to 3/16"

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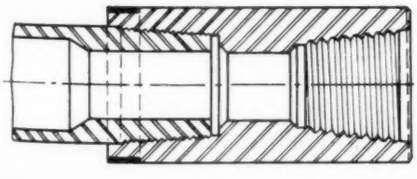

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the jets in the horizontal plane, the energies spent can be more nearly confined to one area than in any other way. The fact that movement of fluid in one direction creates movement of fluid in the opposite direction eliminates the possibility of spiral movement of fluid in jetting operations. As it is possible to confine the energy of jets to one area, the work done may be easily controlled from the surface. With the jets in the same horizontal plane, it is obvious that to increase the amount of kinetic energy derived from each jet will increase the amount of work done by all the jets.

Increasing Kinetic Energy

There are two ways of increasing the kinetic energy of a jet. One is to operate the jet at a greater pressure differential; the other is to increase the size of the jet. The number of jets to be used should never be more than three for horizontal cleaning or drilling, and these should be of a size that will permit the pumping equipment to operate at its most advantageous speed. The reason no more than three jets should be used is that with each additional jet, 2.4 percent of the energy in the jet is lost. The only reason for using as many as three jets is to create a balance in the directions of fluid velocity in the hole. Due to space limitations, the 2-in. size must use 4 jets, one pair above the other and at right angles to each other.

Types of Jetting Jobs

Many successful jetting jobs have been run under various conditions and for different purposes. For each type of job a particular type of acid is used and for each type of job a particular method of operation is used. The two principal classes of uses for jets are: (1) for vertical drilling, and (2) for horizontal drilling. For vertical drilling, a special jet tip is used, which has one large orifice pointed the correct number of degrees from vertical and one small orifice pointed horizontally. This allows cement or limestone to be drilled at a rate that is comparable to cable-tool drilling, and saves the operator the expense of moving in cable tools or other drilling equipment. A cementing plug is being developed that is drillable with acid jet guns, thus making it possible to service any well when casing leaks are present. The casing can be bridged below the leak, the acid-soluble plug and Cal-Seal used, a squeeze made through the leak, and the pipe cleaned out with the jet gun.

In a special method known as water control, wells are jetted horizontally to open the water-bearing formation; then cement is carefully balanced into the formation, leaving a plug that covers both water and oil pay, after which, with this special drilling jet tip, the excess cement is removed a few inches at a time. As soon as any permeability is reached—indicated by loss or gain of fluid at the surface—drilling is stopped and the well tested for production. This process is mentioned only to show the fine degree of control obtained when drilling with acid jet guns. Vibrations from tools, which can cause vertical fractures, is absent. In horizontal jetting, wells may be treated that could not otherwise be acidized. The following are some interesting case histories of wells in Kansas illustrating the advantages gained in jet gun applications.

Specific Cases

More than 125 wells were jetted in Kansas last year, and in several cases the jet method of treatment replaced entirely the conventional method. Some of the results are listed as follows:

Case 1. Well in Prusa area 40 ft. low, made 16 bbl. an hour. After jetting with 500 gal. 15 percent diluted to 1000 gal., made 16,000 bbl. drawdown potential.

Case 2. Arbuckle well in Burnett pool making 20 bbl. per day. Jetted with 500 gal. 15 percent, made 2450 bbl.

Case 3. Arbuckle well treated with 2000 gal., made 1502 bbl. Then jetted with 500 gal. and treated with 1500 gal.; made 2564 bbl.

Case 4. Old well, 2 years old. Had been treated under 2000-lb. pressure. Making 7 bbl. per day. Jetted with 2000 gal. Made 30 bbl. per day.

Case 5. Drilled-out 28 ft. of cement plug in 9 hours with 1500 gal. 15 percent acid, 7-in. hole.

Case 6. Drilled 12 ft. of cement plug in 28 min., using 4 jets and 2 pumps, 1500-lb. pressure, 8⅝-in. casing.

Case 7. Old well had been squeezed and acidized, making 7 bbl. per day. Jetted with 500 gal. Made 50 bbl. per day.

Case 8. New well making 780 bbl. per day. Treated with 2000 gal. Still made 780 bbl. Jetted with 2000 gal. diluted to 4000. Made 7800 bbl.

The jet gun should be used as a first treatment of every open hole well to expose as many channels as possible to acid. This first treatment will often be found to be sufficient.

The equipment used in these jet gun jobs is supplied by the service company, using the owner's tubing, pulling unit, and crew. It is necessary to have a stripper type casinghead through which the tubing may be raised and lowered and turned. Last but not least, it is necessary to have pumping equipment that will develop sufficient power and volume for any type of iob.

The best results from jetting are obtained when energy at the face of the jet is more than 15,000 ft-lb. per sec. This requires that the pumps be able to handle 60 gal. of fluid per min. at 1000-lb. pressure. The average amount of acid used to jet pay formations is 200 gal. of 15 percent acid per ft. of pay. This acid is diluted or not, as the particular formation requires, or depending upon whether or not cement is to be drilled. The average drilling rate for cement is between 1½ in. and 2 in. per min., depending on the size of the hole and the hardness and age of the cement. The amount of acid required to drill cement is 100 gal. of 7 percent acid per cu. ft. of cement to be drilled.

Science Beats Hunches Four to One in Discovering New Oil Fields

OIL-WELL drillers who took the advice of scientists in their search for new oil fields in 1940 were three to four times as successful as the drillers who located their exploratory wells by non-scientific hunches, doodlebugs, dreams, or what-not, says the American Petroleum Institute.

One-tenth of all the wells drilled by the petroleum industry in 1940 were out beyond the limits of present oil fields—wildcat wells drilled in an attempt to find new fields. One-eighth of these wildcat exploratory wells, 366, were successful, opening new oil and gas fields; the remaining 2672 were failures, dry holes.

Most of the wells drilled by the industry are within the supposed bounaries of proved fields, to develop those fields, but every year several thousand locations are picked where no oil has been found, and exploratory wells are drilled. That even one-eighth of these are successful is a tribute to the scientific skill and daring of oil men. Many of these wildcat wells penetrate more than two miles, cost from $150,000 upward, and find nothing but dust.

A number of well sites still are chosen because of guesses, witch-hazel rods, or divine inspiration. Some of them do find oil. Most new drilling locations, however, are picked after detailed scientific surveys, and their chance of success is three to four times as great as those located by non-scientific methods. Of the 1940 wildcats, 2051 were drilled on technical advice —geology, geophysics, or a combination of the two—and 320 of them were successful. Sundry non-technical reasons were the excuse for drilling 832 exploratory wells last year, and only 35 found oil.

Computing Gas Flow in Pipe Lines

☆ Correlation of the various methods of solving gas flow problems—Use of friction factor

PART 1

by P. McDonald Biddison
Consulting Engineer

P. McDONALD BIDDISON

was born at Lane, Kansas, December 13, 1884—In 1904 he graduated from Kansas State College of Agriculture and Applied Science with the degree of bachelor of science in electrical engineering—He served in an engineering capacity with several industrial organizations prior to becoming affiliated with the oil and gas industry in May, 1905, with the Kansas Natural Gas Company and Logan Natural Gas and Fuel Company—Later he became chief engineer for the latter company—In successive years he was with Hope Engineering and Supply Company and Kansas Natural Gas Company—During the next 20 years he was connected in an engineering capacity with a number of companies—This activity was interspersed with considerable work as a consultant—Since the early part of 1927 he has operated as a consulting engineer—Is a licensed professional engineer in the states of Texas and Oklahoma—Makes his home in Dallas, Texas.

The General Equation

THE purpose of this study is to reconcile the various methods of solving gas flow problems, in particular clarifying the use of additional information on friction factor that has become available since the publication of Monograph 6 of U. S. Bureau of Mines.[1] In addition the purpose is to bring to the attention of the natural gas industry the desirability of accumulating additional data acquired under conditions where a reasonable degree of accuracy is obtainable.

For the flow of gas in long lines (i.e., long with relation to diameter, say 200 diameters or more in length) the general equation is:

$$Q = 38.7744 \times \frac{T_0}{P_0}\sqrt{d^5 \times \frac{P_1^2 - P_2^2}{GTLf}} \quad . \quad . \quad . \quad (1)$$

$$Q_h = 1.6156 \times \frac{T_0}{P_0}\sqrt{d^5 \times \frac{P_1^2 - P_2^2}{GTLf}} \quad . \quad . \quad . \quad (2)$$

These equations are applicable to gas flow in pipe lines at either high or low pressures and either large or small pressure drops if we use the proper values of the friction factor f. It is in the expression of the value of f that the various pipeline flow formulas used in the past have differed; equations (1) and (2) being simplified and modified by expressing f in terms of some of the other factors. For convenience we may consolidate some of the terms of this equation.

$$\text{Let } K = 38.7744 \times \frac{T_0}{P_0} \times \sqrt{\frac{d^5}{GT}} \quad . \quad . \quad . \quad . \quad (3)$$

$$K_1 = 38.7744 \times \frac{T_0}{P_0} \times \sqrt{\frac{d^5}{T}} \quad . \quad . \quad . \quad . \quad (4)$$

$$\text{Then } K = \frac{K_1}{\sqrt{G}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

For our examples we will assign values to be used throughout for the measurement base and temperature of flow.

Let $T_0 = 519.6°$ absolute F.
$P_0 = 14.735$ lb. per sq. in. absolute
$T = 519.6°$ absolute F.

$$\text{Then } K_1 = \frac{38.7744 \times d^{2.5} \times \sqrt{519.6}}{14.735} = 59.983\ d^{2.5}. \quad (6)$$

(The use of $60 \times d^{2.5}$ is sufficiently accurate.)

If $G = 0.64$

$$K = \frac{60}{0.80} \times d^{2.5} = 75.0 \times d^{2.5} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

For the conditions assumed we may then write the flow equation as:

$$Q = K \times \frac{1}{\sqrt{f}} \times \sqrt{\frac{P_1^2 - P_2^2}{L}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Single Lines. In solving this equation for pressure conditions when the flow rate is known it is convenient to use it in its squared form:

$$\left(\frac{Q}{K \times \frac{1}{\sqrt{f}}}\right)^2 \times L = P_1^2 - P_2^2 \quad . \quad . \quad . \quad . \quad . \quad (9)$$

For an example assume a line consisting of four sections with intermediate lateral deliveries at ends of each section as follows:

Section	Nominal pipe diameter, in.	Wall thickness, in.	Length of section, mi.	Gas volumes, M. cu. ft. per day	
				Through section	Take-off at end of section
1	24	5/16	36	125,000	25,000
2	22	5/16	49	100,000	15,000
3	20	5/16	36	85,000	15,000
4	20	5/16	25	70,000	70,000

Outlet pressure = 200 lb. per sq. in. gauge.

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Symbols

Q = Rate of flow, cu. ft. per 24 hr., measured at P_0 and T_0

Q_h = Rate of flow, cu. ft. per hr., measured at P_0 and T_0

q = Rate of flow, cu. ft. per sec., measured at P_0 and T_0

T_0 = Base measurement temperature, °F., absolute

P_0 = Base measurement pressure, lb. per sq. in., absolute

P_1 = Inlet pressure, lb. per sq. in., absolute

P_2 = Outlet pressure, lb. per sq. in., absolute

d = Inside diameter of pipe, in.

D = Inside diameter of pipe, ft.

G = Specific gravity of the gas, referred to air = 1.0

T = Temperature of the flowing stream, °F., absolute

L = Length of line, mi.

l = length of line, ft.

f_s = Friction factor, smooth pipe

f = Friction factor, actual

E = Efficiency of flow. The ratio of the actual rate of flow to the rate calculated from the friction factor for smooth pipe.

$$f = \frac{f_s}{E_2}$$

H = Difference in elevation, ft.

R = Gas constant, $\frac{53.33}{G}$ in Appendexes III and IV.

R = Reynolds number, except in Appendexes III and IV.

U = Velocity, ft. per sec.

S = Density, lb. per cu. ft.

Z = Viscosity, lb. per sec. per ft.

Note: Where other symbols are used, they are explained in the text adjacent thereto.

The solution for inlet pressure by use of equation (9) follows. All computations are made on a slide rule. The quantity inside the parenthesis is computed on C and D scales, its square then found on the A scale, this multiplied by the length (on B scale) gives $P_1^2 - P_2^2$ on A scale. The determination of the friction factor is discussed elsewhere under the heading "The Friction Factor."

Section 4. 20-in. by ⅜-in. wall—25 miles

70,000 M. cu. ft.

$K = 75.0 \times d^{2.5}$

$K = 75.0 \times 1626 = 122{,}000$

$R = 1.934 \times G \times Q/d$

$R = 1.934 \times 0.64 \times \frac{70{,}000{,}000}{19.25} = 4{,}500{,}000$

$\text{Log } R = 6.653, \quad \frac{1}{\sqrt{f}} = 19.33$

	Pressure lb./ sq. in. absolute	Squares and differences in squares
At outlet of Section 4	214.4	45,967
$\left(\frac{70{,}000{,}000}{122{,}000 \times 19.33}\right)^2 \times 25.0 =$		22,050
At junctions of Sections 3 and 4	260.8	68,017

Section 3. 20-in. by ⅜-in. wall — 36 miles

85,000 M. cu. ft.

$K = 75.0 \times 1626 = 122{,}000$

$R = 1.934 \times 0.64 \times \frac{85{,}000{,}000}{19.25} = 5{,}467{,}000$

$\text{Log } R = 6.738, \quad \frac{1}{\sqrt{f}} = 19.60$

$\left(\frac{85{,}000{,}000}{122{,}000 \times 19.60}\right)^2 \times 36 =$		45,500
At junctions of Sections 2 and 3	336.9	113,517

Section 2. 22-in. by ⅜-in. wall — 49 miles

100,000 M. cu. ft.

$K = 75.0 \times 2082 = 156{,}000$

$R = 1.934 \times 0.64 \times \frac{100{,}000{,}000}{21.25} = 5{,}830{,}000$

$\text{Log } R = 6.776, \quad \frac{1}{\sqrt{f}} = 19.70$

$\left(\frac{100{,}000{,}000}{156{,}000 \times 19.7}\right)^2 \times 49 =$		51,900
At junction of sections 1 and 2	406.6	165,417

Section 1. 24-in. by ⅜-in. wall — 36 miles

125,000 M. cu. ft.

$K = 75.0 \times 2606 = 195{,}500$

$R = 1.934 \times 0.64 \times \frac{125{,}000{,}000}{23.25} = 6{,}660{,}000$

$\text{Log } R = 6.823, \quad \frac{1}{\sqrt{f}} = 19.90$

$\left(\frac{125{,}000{,}000}{195{,}500 \times 19.9}\right)^2 \times 36 =$		37,100
At inlet of section 1	450.0	202,517

It is apparent that if we had begun with the inlet pressure and computed the sections in reverse order, we could by the same process determine the outlet pressure.

For solution of the flow equation when the pressure conditions are known and the rate of flow is to be found, the value of $\frac{1}{\sqrt{f}}$ may be determined from equations (41), (48), or (53). Using the latter and the same conditions as in Section 4 of the previous example, we have:

$$\frac{1}{\sqrt{f}} = 1.81 \text{ Log} \frac{6.1565 \times d^3 \times G \times (P_1^2 - P_2^2) \times 10^6}{T \times L} \quad \ldots\ldots\ldots\ldots\ldots\ldots (53)$$

$$= 1.81 \text{ Log} \frac{6.1565 \times 19.25^3 \times 0.64 \times 22{,}050 \times 10^6}{519.6 \times 25.0} \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

$$= 1.81 \left(\text{Log } 47{,}700 \times 10^6\right) \quad \ldots\ldots\ldots\ldots (11)$$

$$= 1.81 \ (4.67852 + 6.0) = 19.33 \quad \ldots\ldots\ldots\ldots (12)$$

Substituting values in Equation (8)

$$Q = 122{,}000 \times 19.33 \sqrt{\frac{22{,}050}{25}} = 70{,}000 \text{ M. cu. ft.} \quad \ldots\ldots (13)$$

This operation may also be performed on the slide rule beginning with the quantity under the radical on the A and B scales, finding the square root on the D scale, and completing the answer by C and D scales.

Looped Lines. For loops of various sizes and lengths terminating at the same points, if Q be the total flow, the pressures being given:

$$Q = Q_a + Q_b + Q_c + \ldots\ldots Q_n \quad (14)$$

$$Q_a = K_a \times \frac{1}{\sqrt{f_a}} \sqrt{\frac{P_1^2 - P_2^2}{L_a}}$$

and likewise for other members . . . . . (15)

Again using Equation (53):

$$\frac{1}{\sqrt{f_a}} = 1.81 \text{ Log } \frac{6.1565 \times d_a^3 \times G \times (P_1^2 - P_2^2) \times 10^6}{T \times L_a} \quad (16)$$

$$\text{Let } y = \frac{6.1565 \times G \times (P_1^2 - P_2^2)\, 10^6}{T} \quad (17)$$

$$Q = \left(\frac{K_a}{\sqrt{L_a \times f_a}} + \frac{K_b}{\sqrt{L_b \times f_b}} + \frac{K_c}{\sqrt{L_c \times f_c}} + \ldots \frac{K_n}{\sqrt{L_n \times f_n}} \right) \times \sqrt{P_1^2 - P_2^2} \quad (18)$$

$$Q = 1.81 \sqrt{P_1^2 - P_2^2} \left(\frac{K_a}{\sqrt{L_a}} \text{Log} \frac{y d_a^3}{L_a} + \frac{K_b}{\sqrt{L_b}} \text{Log} \frac{y d_b^3}{L_b} + \ldots \frac{K_n}{\sqrt{L_n}} \text{Log} \frac{y d_n^3}{L_n} \right) \quad (19)$$

$$Q = 1.81 \sqrt{P_1^2 - P_2^2} \left[\left(\frac{K_a}{\sqrt{L_a}} \text{Log} \frac{d_a^3}{L_a} + \frac{K_b}{\sqrt{L_b}} \text{Log} \frac{d_b^3}{L_b} + \ldots \frac{K_n}{\sqrt{L_n}} \text{Log} \frac{d_n^3}{L_n} \right) + \left(\frac{K_a}{\sqrt{L_a}} + \frac{K_b}{\sqrt{L_b}} + \ldots \frac{K_n}{\sqrt{L_n}} \right) \text{Log } y \right] \quad (20)$$

If the lengths be the same for all members of the loop:

$$Q = 1.81 \sqrt{\frac{P_1^2 - P_2^2}{L}} \left[\left(K_a \text{Log} \frac{d_a^3}{L} + K_b \text{Log} \frac{d_b^3}{L} + \ldots K_n \text{Log} \frac{d_n^3}{L} \right) + \left(K_a + K_b + \ldots K_n \right) \text{Log } y \right] \quad (21)$$

If the diameters be the same, but not the lengths:

$$Q = 1.81\, K \sqrt{P_1^2 - P_2^2} \left[\left(\frac{1}{\sqrt{L_a}} \text{Log} \frac{1}{L_a} + \frac{1}{\sqrt{L_b}} \text{Log} \frac{1}{L_b} + \ldots \frac{1}{\sqrt{L_n}} \text{Log} \frac{1}{L_n} \right) \times \text{Log } d^3 + \left(\frac{1}{\sqrt{L_a}} + \frac{1}{\sqrt{L_b}} + \ldots \frac{1}{\sqrt{L_n}} \right) \text{Log } y \right] \quad (22)$$

If diameters and lengths be the same, n being the number of lines:

$$Q = \frac{nK}{\sqrt{f}} \sqrt{\frac{P_1^2 - P_2^2}{L}} \quad (23)$$

$$Q = 1.81 \times nK \sqrt{\frac{P_1^2 - P_2^2}{L}} \times \text{Log } y d^3 \quad (24)$$

The quantities flowing in the several lines are in relative proportions, from Equation (19):

$$\frac{K_a}{\sqrt{L_a}} \times \text{Log} \frac{y d_a^3}{L_a}, \quad \frac{K_b}{\sqrt{L_b}} \times \text{Log} \frac{y d_b^3}{L_b} \text{ and } \frac{K_n}{\sqrt{L_n}} \times \text{Log} \frac{y d_n^3}{L_n} \quad (25)$$

It is obvious that as the pressure conditions change, producing changes in y, the factors of size and length being constant, the proportions will vary so that looped lines can be expressed as equivalent lengths of some chosen diameter only at a given rate of flow, the equivalent length changing as the flow rate changes. And this is true even if the size and lengths be the same for all members of the loop.

To solve a looped line for pressures when all members are the same size and length requires only the equal division of the flow between them and the procedure outlined for single lines. If the sizes and lengths are not the same then either of two methods may be used: (1) compute the difference in squares for each member separately at three or more rates of flow judged to be near the actual rate, plot the results and from them make a composite plot of flow against differences in squares from which the answer may be read, or (2) assign values to the difference in squares in the function y judged to be near the actual difference. Substantial error may be made in this choice without incurring much error in the ultimate result.

The Friction Factor

Experimental work by Nikuradse[3] has extended our knowledge of friction factors for smooth pipe into regions of flow conditions that are comparable with those found in practice on natural gas transmission lines. He has supplemented this work by experimental determinations of the effect of wall roughness.[4] But the surfaces of commercial pipe lines seem not to conform to the smooth pipe condition, and the relative roughness and Reynolds Number relationship is usually indeterminate and difficult of application. In practical design, one may work from the Nikuradse curve for smooth pipe with the application of an efficiency factor derived from experience or determined by test on the system under consideration. If we define efficiency as the ratio of the theoretical flow for smooth pipe to the actual flow, f_s as the friction factor for smooth pipe, and f as the actual friction factor, then:

$$E = \frac{Q}{Q_s} = \frac{f_s}{f} \quad (26)$$

$$f = \frac{f_s}{E^2} \quad (27)$$

$$\frac{1}{\sqrt{f}} = E \times \frac{1}{\sqrt{f_s}} \quad (28)$$

$$\frac{1}{\sqrt{f_s}} = \frac{1}{E\sqrt{f}} \quad (29)$$

The Nikuradse results on smooth pipe have been expressed in two ways:

$$f_s = 0.0008 + 0.0552\, R^{0.237} \quad \text{(reference}^3\text{)} \quad (30)$$

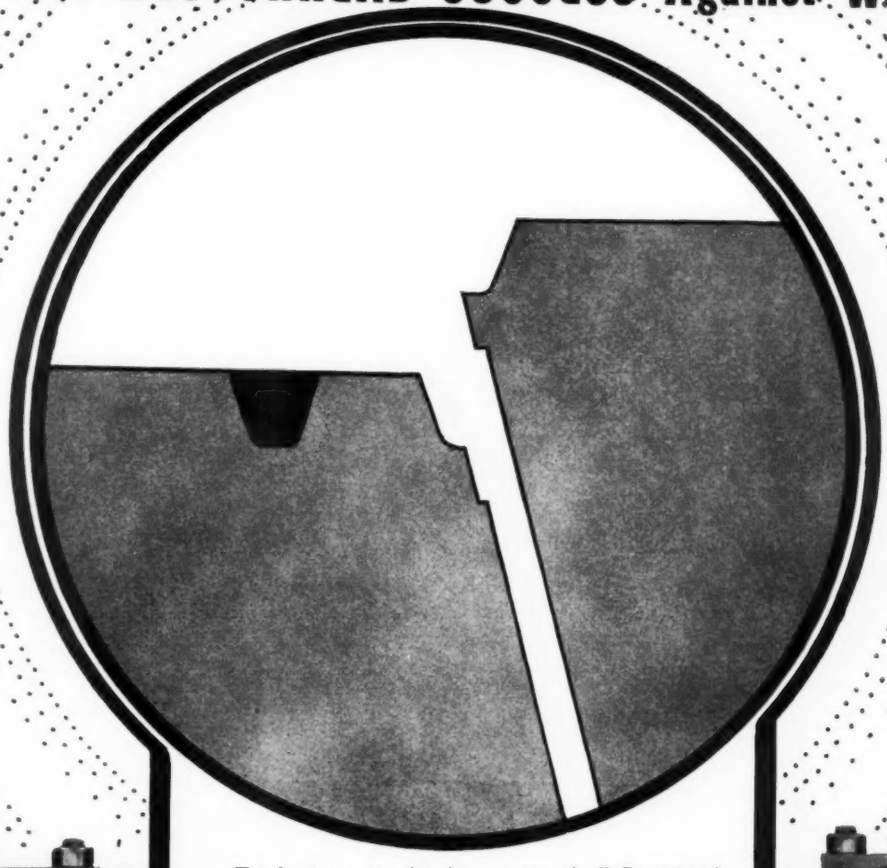
$$\frac{1}{\sqrt{f_s}} = 4 \text{ Log } (R\sqrt{f_s}) - 0.4 \quad \text{(reference}^5\text{)} \quad (31)$$

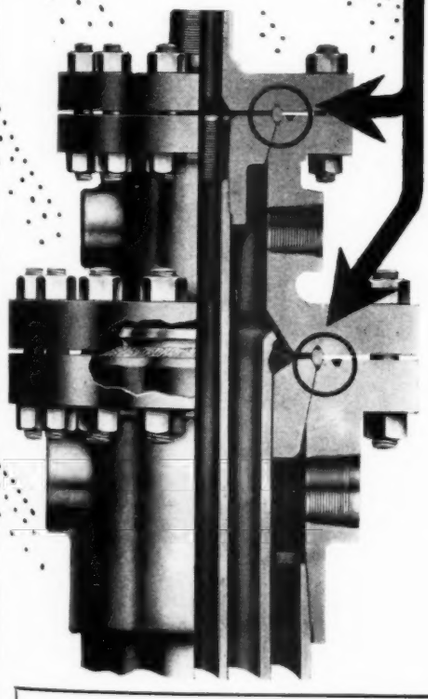
Equation (31) is the preferred form. Benjamin Miller uses it in his analysis of gas flows[7,13] and Drew and Genereaux[5] refer to it as the form "that should undoubtedly be adopted in preference to the numerous relations" of the form of equation (30). Kalinsky[6] states "Prandtl and others have shown that this equation holds for all values of R in the region of turbulent flow." Inasmuch as a sound theoretical relationship is safer for extrapolation into fields outside the range of experiments, the form of equation (31) will be used herein. In this connection it should be noted that the experimental data on smooth pipe extends only to about R = 3,000,000 and that laboratory work on commercial pipe lags behind that. The work of Nikuradse on rough pipe will not be discussed here. Although commercial pipe does not conform to the condition of smoothness of the smooth pipe of his experiments, neither does its character of roughness fully correspond to the artificial roughness by sand grains in his experiments. In commercial pipe the character and degree of roughness may be from surface roughness, from waviness, from joints, flattening at bends or from any kind of combination of these causes. (For a discussion see paper by R. A. Ransom.[8]) Considering the present stage of understanding of the subject, the writer prefers to adhere to the data on smooth pipe and on commercial pipe lines modified from time to time as additional information is accumulated.

EDITOR'S NOTE: This article will be continued in an early issue of *The Petroleum Engineer*. Footnote references will be included in the final installment.

The Protected GROUND JOINT Seat

Is the Secret of RECTORHEAD SUCCESS Against Well Pressures





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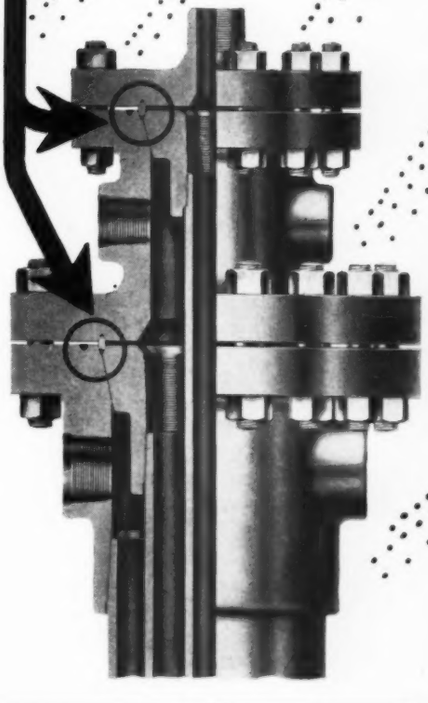

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P 615.

Talent Along the Pipe Line

by L. E. Adler, Communication Engineer, Magnolia Pipe Line Company

THE average layman, whose only contact with the pipe-line industry may have been to watch a gang of laborers digging a ditch, is apt to classify a pipe-liner as a benighted individual who is rich in profanity, poor in culture, low in morals, and high in illiteracy. He is presumed to have no objectives in life other than liquor, gambling, women, payday, and overtime.

What's wrong with this picture? *Practically everything,* to one who really knows.

As an illustration: Just recently, it was the writer's pleasure to make a telephone transmission survey that included the Gulf Refining Company's pipe-line system from Tulsa, Oklahoma, to Centralia, Illinois. In addition to officials, I met many of the station personnel over the entire 400-mile route. I have never seen a more coöperative organization, nor a higher grade of station maintenance. But what impressed me most forcibly were the various hobbies and remarkable talents of many of the individuals in the group. No doubt I missed several others in the brief time at my disposal.

Here at least are the highlights of the trip:

To begin with, the superintendent himself, Arthur Ray, is a very talented amateur musician and violinist.

At Tulsa, the wire chief, Mr. Goldsmith (Goldie to his friends), has a 12-year-old daughter whose musical abilities have won her a regular place on broadcast programs emanating from Tulsa stations.

The engineer at Monett station is a real artist at oil painting. One of his works, a complete landscape of the station and grounds, is good enough to hang in any gallery. Woven in the beautiful cloud effect is a clever "commercial plug," with the correct light and at the proper angle, the word "Gulf" being discernable in the cloud formation.

The home of Chief Engineer Key at Strafford station contained most of the major instruments of the modern orchestra. His wife and five children play them all in a manner that no professional could criticize. Being an ex-musician myself, I spent a very pleasant hour with these most talented and accomplished youngsters.

At Steelville, one of the station operators had the most complete and elaborate "ham" radio station I have ever seen. Most of the equipment on the five steel floor racks was self-constructed and represented a large investment. It took him only a few minutes to grasp the entire circuit design of the telephone equipment that I was engaged in testing.

Another engineer at Strafford is the champion fisherman of the line, and can lure 'em from Lake Lebanon when all others fail. I was sorely tempted to take time out with him but the schedule forbade it.

The whole experience was a great lesson of contentment in far-flung places. What a pity that everyone does not realize what a fine, wholesome contribution to happiness these hobbies and avocations can really be.

P 094.6

Methods of Solving the Oil-Soaked Belting Problem

by W. F. Schaphorst

ALTHOUGH oil does not seriously damage some belts an excessive amount of oil does cause slipping. As soon as slip occurs there is an unnecessary power loss that is directly proportional to the slip. For instance, if the slip amounts to 2 percent the power loss is 2 percent. If the slip is 5 percent the power loss is 5 percent. In other words, percentage of power loss is identical with the percentage of slip.

Continued use of a leather belt soaked in mineral oil will develop cracks from fiber abrasion inside. The natural animal oil in high-grade leather protects these fibers from inner abrasion. Harsh mineral oil removes this film of natural animal lubricant, and allows the fibers to contact and develop abrasion. Degreasing will remove the mineral oil and redressing with animal oil will replace the film on each fiber, thus maintaining pliability without internal damage.

Excessive slip may also cause burning of the belt. Burning is often more serious than the power loss, cracking, and abrasion combined. It can be very expensive.

There are two ways in which to tackle this oil-soaked belting problem: (1) improve the condition of the oil piping, etc., if possible so that there will be no leakage or splattering onto the belt. By so doing, it will not be necessary to give the belt a periodic cleaning, and (2) use a belt that is as immune as possible to being harmed by oil and then clean that belt periodically.

Numerous cleaning agents are used for washing leather belts such as gasoline, naphtha, kerosine, benzol, carbon tetrachloride, aqua ammonia, alcohol, soda, and water.

In general these rules may be followed: Immerse the loosely wound coil of belting on edge, in the liquid, and allow to soak overnight. Then stand on the other edge for 10 hours. If the belt is dirty in addition to being oil-soaked, the dirt usually loosens and settles to the bottom. The dirt that does not loosen and settle can generally be removed with ease by brushing or scraping. To hasten drying, the belt may be run through an ordinary washing wringer, provided the belt is not too wide. If the belt is dry lubricate it with a suitable dressing recommended by the manufacturer of the belt.

When using gasoline or naphtha be extremely careful. According to the U. S. Bureau of Mines, if gasoline is stored in an open container, as in a pail, the atmosphere of the room in which the pail is left will soon become explosive. The limits of explosibility are between 1.5 and 6 percent of gasoline vapor in air. Therefore, only a small volume of gasoline vapor is needed to cause the air to become explosive —1½ cu. ft. of gasoline vapor for each 97½ cu. ft. of air. One gallon of gasoline can, when perfectly mixed, render 2100 cu. ft. of air explosive.

Some types of pulleys also collect oil and become "oil soaked". An oil-soaked belt on oil-soaked pulleys is a very poor combination for power transmission. Pulleys can be degreased as well as belts by a process very similar to that described.

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2. Full-Port Lubricant Sealing Grooves.
3. Wedge-Proof cylindrical Super-Surfaced Core.
4. Sealing Grooves on Plug never pass Ports.

1. **AUTOMATIC LUBRICATION**—Provides a constant lubricant seal • Line pressure automatically forces lubricant from reservoirs to sealing grooves • Eliminates necessity of frequent operation of lubricant screw • Ample downstream (sealing end) lubrication • Reduces friction—valve turns easily • Reduces wear and extends life of valve

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4. **SEALING GROOVES ON CORE**—Never exposed to fluid • Prevent loss of lubricant into fluid line . . . insures constant seal • Protects sealing grooves on core from direct cutting action of fluid • Lessens intrusion of abrasives into lubricant sealing grooves . . . reduces wear on vital sealing surfaces • Prolongs life of valve

*When lubricating a Mission Plug Valve, a portion of the lubricant is forced into reservoirs. Thereafter, the line pressure AUTOMATICALLY feeds this stored lubricant, as needed, into the downstream seal grooves. So long as lubricant remains in the reservoir a perfect seal is assured.

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Method of Extinguishing Burning Well in West Texas

THE accompanying photographs indicate more clearly than words the method whereby a recent oil well fire was extinguished.

The well, Schermerhorn Oil Corporation's J. L. Johnson No. 14-B in the Foster pool, six miles northwest of Odessa, Texas, caught fire when tools and drilling lines were blown out of the hole. Sparks ignited the gas and oil.

The well had been shot with 487 quarts and was producing 6,000,000 to 8,000,000 cu. ft. of gas daily and 60 bbl. of oil and water hourly.

The hole bridged after the shot and the well suddenly blew out when tools penetrated the bridge. The hole rebridged near the top but broke again, blowing the tools out. A string of 7-in. casing had been cemented at a depth of 3956 ft.

H. L. Patton, fire fighter, of Houston, Texas, used the equipment shown in the photographs to control the well.

Photographs were taken by L. H. Tiffin, commercial photographer, Midland, Texas.

Fig. 1. Showing the burning well before hot metal had been cleared away.

Fig. 2. The manifold, especially designed by H. L. Patton for such work, was suspended from the truck boom as shown.

Fig. 3. Backing the truck slowly toward the well, the assembly was brought into position for lowering.

Fig. 4. Lowering the stem into the open casing, the fire is extinguished. Two flow lines and valves permit full control of the well.

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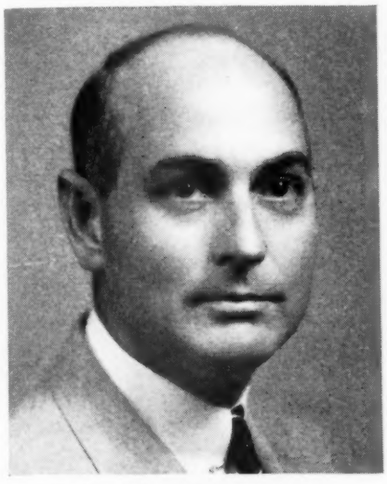

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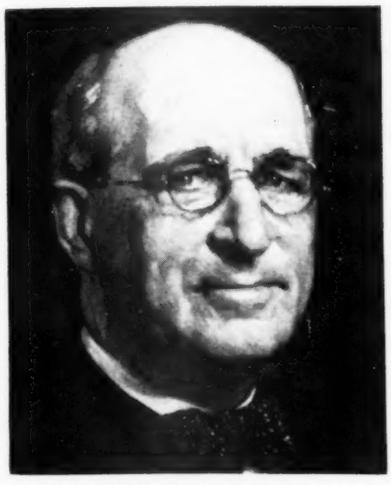

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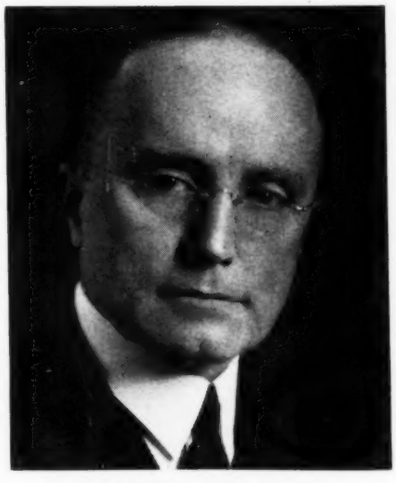

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(Continued on Page 66)

WE WENT MORE THAN A MILE BELOW

MORE EXAMPLES OF NIXON GAS-LIFT ADAPTABILITY

The only similarity between these two problem wells is that they are both deep and both were having production difficulties. Even though the difficulties and their cause were of an entirely different nature, Nixon Gas-Lift engineers were able to solve them by the installation of a Nixon Surface Control Gas-Lift System.

IN CALIFORNIA

This well had producing zones flowing through perforated casing at 5,600 ft., 6,875 ft., and bottom, 7,297 ft. With an open gas-lift, when pressure was applied to the casing, the top formation ceased flowing.

A Nixon *closed* intermittent sub-packer installation was the solution of the problem. A Nixon Bottom Hole Operating Valve was set at 5,566 feet, with 3″ tubing extending to bottom, where a standing valve was set at 7,290 ft. A hook wall packer set at 5,576 ft. between operating valve and top formation, seals off all three producing formations from operating gas pressure.

Inside the 3″ tubing, extending from operating valve to a point just above standing valve there is a 1¼″ macaroni string. Fluid-lifting pressure is intermitted through the bottom hole operating valve, into annulus between macaroni string and tubing, to force fluid up through the macaroni string.

This installation is actually producing from about 7 ft. off bottom, while packer and operating valve are 1,721 ft. above. Since this installation production has increased from 55 to several hundred barrels daily.

ON THE TEXAS GULF COAST

This well is typical of many 9000 footers. It has a sand of fairly low productivity and a natural flowing life that is very erratic.

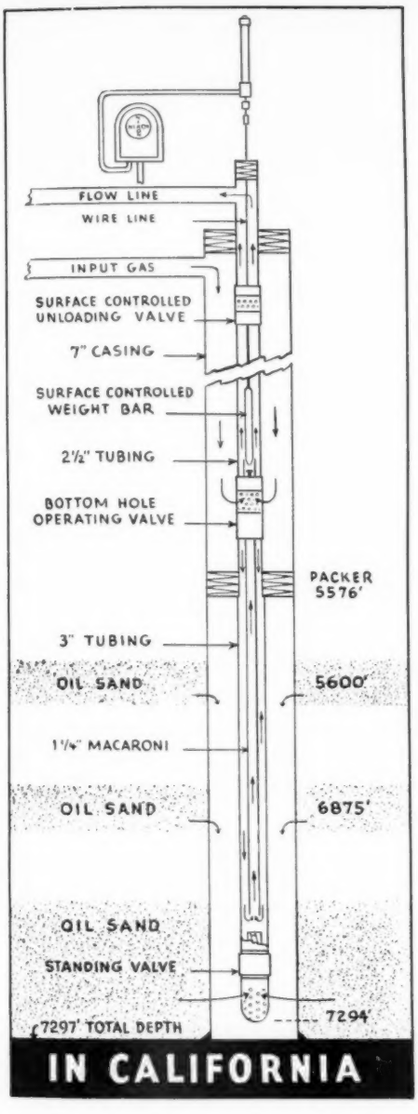
It was originally completed with a series of Nixon Surface Control Flow Valves set in the tubing. When natural flow ceased, the casing area was unloaded of fluid by applying gas pressure and opening each succeedingly lower flow valve to produce flow through the tubing. It has a hook-wall packer set at 9,115 feet, just above the producing formation, which seals it off from operating gas pressure.

Natural pressure during the well's early flow life raised the fluid to a height of more than 1,000 ft., in the tubing, so that flow valve located at that level was operated to lift fluid to the surface.

But as natural pressure declined and the fluid level dropped the weight bar was lowered on its wire line to operate the flow valve, at lower flow levels. Eventually the flow valve immediately above the packer will be operated to lift fluid from that point.

Following prduction down to bottom is done without coming out of the hole or installing additional equipment.

TO GET THEIR FLOW!

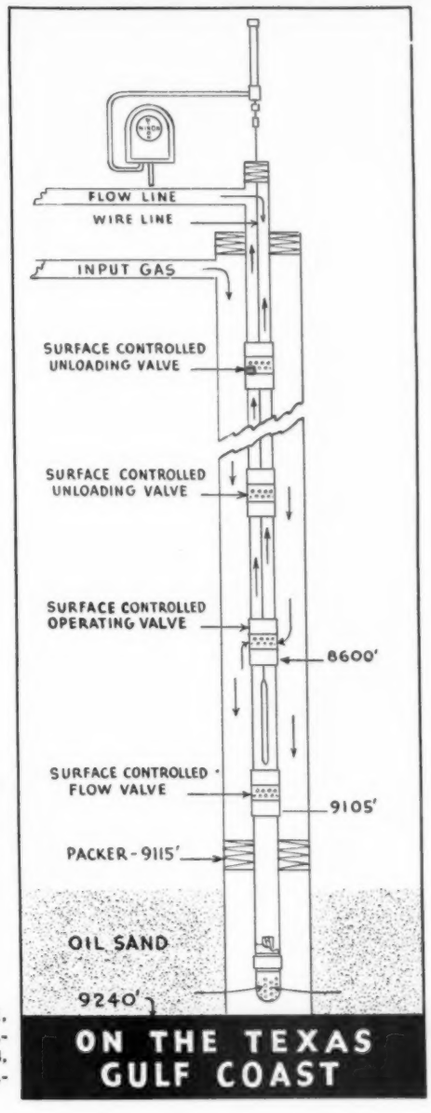


IN CALIFORNIA

NIXON *Surface Control* GAS-LIFT SYSTEM

Patents Issued

Reissue No. 21,199, Patents No. 2,132,081, 2,164,469, 2,171,478, 2,171,480, 2,202,462, 2,171,-812, 2,204,817, 2,245,002, 2,245,003, 2,245,004, 2,245,005, 2,245,006, 2,245,008, 2,245,009, 2,245,-010.



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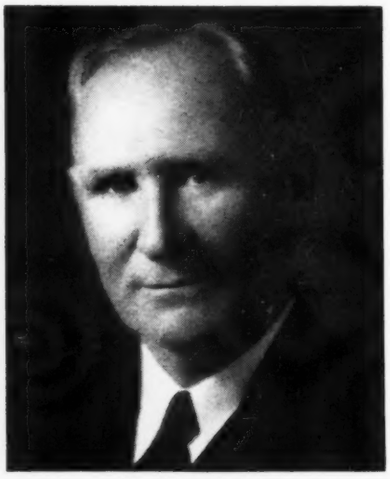

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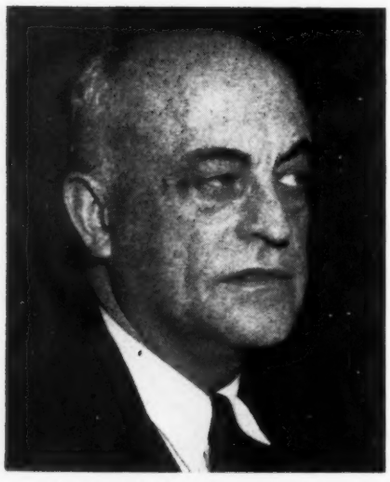

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Refinery Practice for the Operating Man

Vocational Class Proceedings in Refinery Engineering

Thermal Cracking

Synopsis of Preceding Meetings

The first discussion involved a review of the various hydrocarbons and their thermodynamic qualities as related to the cracking of petroleum and its products. The main hydrocarbons in petroleum and its cracking products are paraffins, olefins, naphthenes, and aromatics. Of these olefins are virtually non-existent in most crude oils.

Points covered in the discussion included the following: (1) chemical stability of compounds; (2) relative crackability of hydrocarbons; (3) energies released or absorbed in cracking; (4) the decomposition reactions, and (5) effect of pressure on reactions.

In discussing the development of cracking, it was pointed out that the ability of petroleum to crack was discovered by the accidental overheating of a topping shell still, resulting in an unexpected straw-colored distillate, which was in reality cracked distillate.

Of the earlier cracking processes that followed the first patents on cracking granted to Young and Benton in 1865, the following were discussed: (1) the Benton unit; (2) the Burton-Clark unit; (3) the Coast still; (4) the Fleming still; (5) the Dubbs process; (6) the Isom process; (7) the Cross unit; (8) the Jenkins unit; (9) the Holmes-Manley unit; (10) the Winkler-Koch still, and (11) the Gyro vapor-phase unit.

The importance of clean recycle was first recognized when operators of earlier units discovered that clean stocks permitted longer runs with correspondingly small percentage of gas and coke formed.

In discussing the methods whereby maximum gasoline yield might be obtained by cracking, it was brought out that experience shows that a high reflux ratio results in a smaller yield of gas because of lighter cracking. It was decided to run to coke with as little gas formation as possible. If the residue is fuel oil there is bound to be some gasoline in this liquid product.

Additional gasoline will be obtained if a multiple coil heater is used so that more rigid control from the fractionator will permit separate cracking from the various cuts at optimum conditions. Quenching will be essential to correct control of the time and temperature element.

The excessive heat brought to the fractionator from the reaction chamber can be disposed of in a number of ways: (1) the charge may be used as a quench; (2) heat can be exchanged with the charge to any adjacent unit; and (3) the remaining heat must be removed by reflux in the usual way.

The charging stock is less refractory than recycle stock. A cut cracked above its optimum temperature will produce excessive amounts of gas and coke. For maximum gasoline, therefore, it is necessary to separate both the charge and the recycle stock into small cuts. This would necessitate the separate treatment of charge and recycle. These cuts would then be treated at the temperature at which minimum gas is formed and quenched immediately to keep down the formation of polymers and condensation products that reverse the process of cracking and go to form coke. All this procedure would mean many cuts and high recycle ratio. Of course, for practical purposes the above method would have to be modified in order that investment in equipment would be within reason.

If advantage is taken of all present-day developments in cracking it was decided that 75 percent gasoline yield was about the ultimate to be expected.

The time of reaction in cracking doubles when the temperature increases approximately 20 degrees, making it difficult to control the reaction above a certain temperature; in addition, large amounts of gas and coke are obtained.

Refuting the belief that there is a large percentage of free carbon in petroleum coke, reference to several authorities indicate that, on the contrary, coke consists principally of polymerized and condensed hydrocarbons poor in hydrogen and aromatic in nature. Coke is essentially a control product in the operation of a cracking still inasmuch as it is economically necessary that its quality be high if it is to be salable.

Class Meeting No. 6 (Continued)

2nd Pupil: In cracking paraffins in the selective part of the furnace, we would crack the paraffins and olefins so nothing else could happen, wouldn't we? Why wouldn't we have high lead susceptibility?

Pupil: To make aromatic or cyclic compounds requires higher temperature —950° to 1200°F. (510° to 649°C.), and there will be a minimum of aromatics formed.

Leader: Let's list as our sixth point: (6) Gasoline poor in cyclic compounds relative to severe cracking. (7) Gasoline rich in paraffins relative to severe cracking. How about the olefin?

Pupil: It would be rich in olefins due to severe cracking.

Leader: Let's put olefin content, question mark. Summarizing, we have: Results of maximum gasoline yield

1. Low gas yield
2. Minimum coke due to condensation and polymerization
3. Low octane number
4. Low gasoline volatility
5. No intermediate products
6. Gasoline poor in cyclic compounds
7. Gasoline rich in paraffins
8. Olefin content (?)

Let us set up a hypothetical case.

Any unit we might build would have to be designed for local conditions. I don't believe that the operation of a coking unit is out of the question. I believe that is very practical in certain parts of the Mid-Continent area.

Let's list the following conditions:

10,000 bbl. per day—26° A.P.I. residuum
70 A.S.T.M. octane gasoline
10-lb. Reid vapor pressure. (This is maximum 70-octane A.S.T.M.)

Salable coke.

Any other requirements necessary?

Pupil: Would we say salable slack coke suitable for boiler fuel? I think that is rather a vital point. Lump coke is different from this.

Leader: Let's put down coking unit, and we shall attempt in class to thresh out the details. Do we wish to specify the number of coils in the multiple coil operation?

Pupil: I suggest a maximum of 3 coils be considered.

Leader: All right, we will consider a 3-coil heater as a maximum. I made this charge large enough so that I figured the 3-coil operation would be feasible. Is there any other information that should be included? I want to be sure all the group leaders get this down.

Pupil: Are we establishing yields also, as well as flow sheet?

Leader: I should think so.

Pupil: I thought the yields were established already.

Leader: Estimated yields. Any other points? Are there any other questions that should rightfully come up this evening?

Class Meeting No. 7

Leader: The objective of this evening's meeting is to complete the work on thermal cracking; the application

of our previous discussions to the flow diagram. I believe we have concluded that maximum gasoline yield required operation of a multiple coil system with a fairly high recycle ratio and the minimum practical temperature. We have diverged from the original scheme to the extent of working out a scheme for making not maximum gasoline yield, but the maximum yield of 70-octane gasoline. In what way is it necessary to change the processing from the method used to make maximum gasoline yield to the revised method of making 70-octane gasoline?

Pupil: It is necessary to change from a low crack per pass to a high crack per pass, otherwise retaining essentially the same setup.

Leader: And what are the reasons for going from a low crack to a high crack per pass?

Pupil: The reason is to carry the reaction to a further degree than previously and high crack per pass best does that.

Leader: In other words, that is for the purpose of obtaining maximum octane number?

Pupil: The octane number requirement, which is very close, however, to maximum for thermal refining.

Leader: How near to the maximum for thermal cracking is 70 octane? I think we said 70 A.S.T.M.

Pupil: Pretty close to it.

Leader: In other words, that is about the best we can get from thermal cracking without an enormous sacrifice in yield?

Pupil: Yes. With Mid-Continent crude.

Leader: Has the problem then changed from one of maximum gasoline to maximum octane number—is that really the change that we have made?

Pupil: Essentially so.

Leader: What are the other considerations—in other words, is it possible to retain the features of high octane number with a reasonably high gasoline yield?

Pupil: Yes, I think it is.

Leader: And how is it possible to retain this feature?

Pupil: By separating the fractions and cracking them at more ideal temperatures; in other words, our group didn't expose the whole charge to the high cracking that is necessary for reforming to obtain 70 octane.

Leader: Does the mere separation of the fractions insure the best results?

Pupil: The more selective the cracking on definite cuts from the charge, the better will be the control over cracking.

2nd Pupil: The essential feature of the multiple coil is that it is not necessary to keep the temperature down on the dirty oil coil because of coke formation. There is a maximum time and temperature limit on the dirty oil coil and by having one or more additional coils you can crack at higher temperature with more crack per pass and obtain the better octane fuel.

Leader: Do you believe that the manufacture of 70-octane gasoline from a residuum offers much latitude in operation?

Pupil: Yes, there is some latitude in the manufacture of regular octane. I would vary the operation depending on the market for by-products; it would be ridiculous to manufacture coke if you were in an area where you could sell fuel oil at $1.40 per bbl., and there was a poor coke market.

Leader: Do you believe it is possible to make 70-octane either with fuel oil or coke?

Pupil: Yes.

Leader: We almost concluded formerly that we would have to make coke. What change of conditions is it that allows us to make fuel oil?

Pupil: There is no way, so far as I know, that you can make a fuel oil and maintain maximum gasoline yield of 70-octane as compared with coke operation and maximum gasoline.

Leader: We have no latitude?

Pupil: You must make coke if you want maximum yield.

Leader: And we must crack rather severely or deeply if we want 70-octane?

Pupil: That's right.

Leader: I should like to ask a question of one of the practical cracking operators here tonight. What is the difference in temperature on the outlet of your furnace when you make coke as compared with the cracking of gas oil to fuel oil bottoms?

Pupil: If we run gas oil to residuum there is about 25° difference.

Leader: The gas oil is 25° higher than the residuum?

Pupil: No. Lower than the residuum.

Leader: Doesn't that contradict some of the statements we have heard in regard to the difficulties when cracking residuum under severe conditions.

Pupil: On the Dubbs on coke runs, temperatures are about 925° to 940°F. (496° to 504°C.) and on the gas oil unit around 900°F. (482°C.) with a liquid residue (fuel oil).

Leader: Does anyone wish to volunteer an explanation for that difference?

Pupil: Well, if we run at higher temperature on a gas oil with a fuel oil residuum produced we would make coke; there is a way, however, we could run to higher temperature by quenching, which we have done some times.

Leader: In other words, you can run the lighter oil to higher temperature by quenching?

Pupil: Yes.

2nd Pupil: Probably there are several remarks that should be considered in discussing the temperature at which you should operate. In the first place, operating on the fuel oil charge to produce coke, there is a relatively short time factor when high temperature prevails so that a higher temperature can be used than with a soaking chamber to get increased time. On gas oil operation, producing a fuel oil residue we have a longer time factor with the temperature employed so that we are about equalized with the time for the lower temperature. If we take gas oil, however, and operate to produce coke in the same equipment employing the same space factors on soaking it is necessary to use a much higher temperature than when charging topped crude or residuum.

Leader: Generally speaking, isn't it true that on gas-oil operation, you tend to obtain the additional time by leaving the oil in the furnace longer, whereas on the residuum operation you attempt to get the oil out of the furnace as quickly as possible?

Pupil: Yes, and hold that oil for whatever time you desire under such conditions that it will not cause the operation to cease.

Leader: Generally speaking, is coke deposition in furnace tubes a greater problem in dark oils than in light oils?

Pupil: In dark oils.

2nd Pupil: In light oils, I should think.

Leader: Let one of the cracking operators tell us his experience.

Pupil: Dark oils create more coke in the tubes.

Leader: Do you have more trouble in the residuum furnace than you do in the gas-oil furnace?

Pupil: We get more coke.

2nd Pupil: I think that carbon residue will usually be the index, but dark oils have a preponderance of carbon residue.

Pupil: You have about 3/16 in. of coke in the Dubbs tubes at the end of a cycle?

2nd Pupil: Yes, in about an 80-hr. cycle.

Leader: When is that coke formed?

Pupil: You mean at the last part or the beginning of the run? The coke is formed as the temperature goes up.

Leader: Then how is it possible to operate continuous coking?

Pupil: It can be greatly assisted by carrying a recycle ratio that is higher than that used on the Dubbs so that the carbon residue test will be 1 percent or less as the oil enters the tubes.

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Temperature should be 940°-950°F. (504°-510°C.) with residuum as the raw charge. Under these conditions we can operate satisfactorily for a month or more.

2nd Pupil: Can't you do the same thing by not having any recycle ratio and reducing the temperature?

1st Pupil: It is doubtful; the recycle ratio is 3½ to 1 on the Dubbs.

3rd Pupil: It may be as high as 4 or 5.

Leader: On some of the newer coking furnaces, the charge is much heavier—has a higher carbon residue than the charge employed on the Dubbs operation as we know it. How do they manage that?

Pupil: They introduce the charge into the furnace outlet before it gets to the reaction chamber; consequently the original charge is kept out of the coil. It will eventually come back to the coil, but the first part of it is often introduced into the outlet of the furnace before it hits the reaction chamber.

Pupil: In one of the reference books[1] regarding pressure drops it is stated that in charging 4000 bbl. per day of 48.3° A.P.I. residuum, the pressure drop through the still is 173 lb.

Leader: Is it possible to charge as high a cold velocity on gas oil as on residuum?

[1]*Design of Pipe Stills* by Bell.

Pupil: I should not think so because of gas formation from the gas oil.

Leader: Does the coke formation become greater with gas formation?

Pupil: Yes.

Leader: Then in order to retard coke formation in the tubes, is it necessary to control gas formation?

Pupil: I think you can get out on a limb on that statement—it may just be dehydrogenation.

Leader: I am speaking of permitting liquid to vaporize in the tubes.

Pupil: I mean gas formation does not necessarily indicate coking.

2nd Pupil: If gas forms in the tubes then the coke that is formed is very much more likely to drop out in the tubes, isn't it? If there are gas pockets in the charge going through the tubes, they will not hold the coke like the heavier residuum will at a higher velocity.

3rd Pupil: Somewhere the statement was made that as the formation of gas increases, there is a tendency for a film of liquid to form on the walls of the tubes that will turn to coke. Often due to heat transfer rate through the tube, the heat on the inside of the tube at that particular part will be 100° or higher than were there turbulent flow. If you incur gas formation you run into that condition.

Leader: For the same size of tubes, which furnace has the greatest charging capacity—the one in which liquid is maintained or gas evolved in the tube?

Pupil: The liquid furnace.

Leader: What would be the effect on the capacity of a furnace operating first at low pressure with gas formation and secondly, at high pressure with substantially liquid in the tube?

Pupil: The furnace handling the liquid will have a greater heat transfer capacity.

Leader: Isn't it also true that the heavier the material in the furnace is (as regards specific gravity), the more uniform the temperature of the oil in the tube will be and that as the oil becomes lighter, the temperature differential between the tube and the interior increases? Now, my contention is that coke formation is a greater problem on lighter oils than in heavier, dark oils.

Pupil: Suppose you talk about naphtha—I disagree with you on that.

2nd Pupil: Why would there be more difference in the light than in the heavy?

Leader: You should be able to answer that purely on the basis of rate of heat transfer of the heavier product as compared with the light product.

Pupil: There are other factors besides the rate of heat transfer, surely.

Leader: If the wall of the tube is 200° hotter than the interior, you have a very poor cracking condition. In order to get a satisfactory cracking, you would have to heat the entire mass of material in the tube, and in so doing overheat the outside.

Pupil: You would not get as much turbulence with a lighter oil, would you?

Leader: Yes.

Pupil: I thought you got more turbulence with a light oil.

2nd Pupil: You increase the turbulence of the heavy oil by increasing the velocity. (Page 228, Sachanen.)

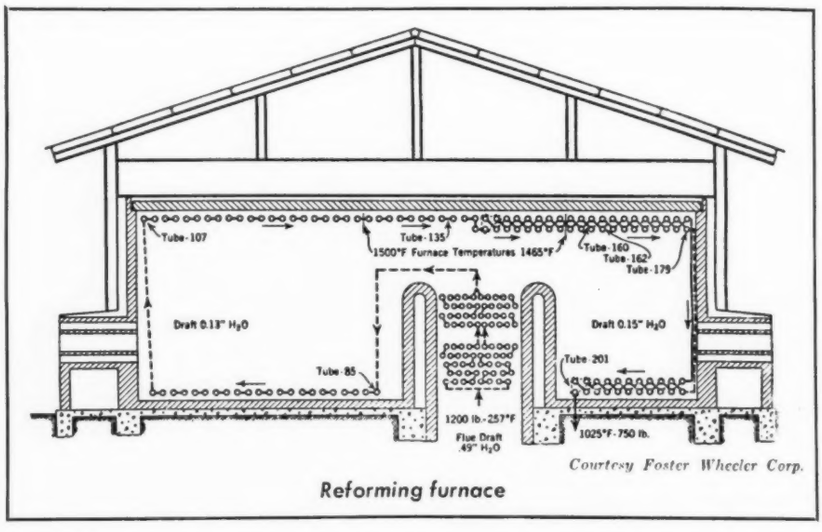
Leader: I believe we can be safe in saying that the limiting factor on heavy stock is the temperature of coke formation; the limiting factor on lighter stock is the available equipment—isn't that correct?

Pupil: I think so.

2nd Pupil: About pressure drop to your furnace: There is no law against having parallel flow, is there?

Leader: What do you think about parallel flow in a high-temperature light-oil furnace?

Pupil: If the stock is light enough (light naphtha) so there is practically no tendency to coke it should be all right. In medium temperature operation parallel flow is fairly satisfactory, but for extreme temperature, flow should be strictly in series. When the desired capacity is above that permissible with one coil, separate pumping facilities for each parallel coil will meet the situation.



Courtesy Foster Wheeler Corp.

Reforming furnace

Pupil: On page 234 of Sachanen, there is a reforming furnace shown. (Reproduced on this page.) The author indicates parallel flow is used and it looks all right. That must be the reason he used parallel flow, to cut down pressure drop caused by extremely high velocity.

Pupil: Isn't it designed with a heating zone and soaking zone? I think all they do with that final section is maintain the temperature.

Pupil: Couldn't they use a series flow and increase the temperature? You would have a greater velocity.

Leader: Would anyone like to ask any questions on the various methods?

Pupil: When all 3 coils are in the same furnace does that mean all would be fired together?

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Pupil: No, all three are separately fired.

Pupil: We have all listened to the same discussion, and I find too many differences. In one method three coils are so used that two of the coils are operating at 890° and 835°F. (477° and 446°C.), respectively, on different oils—the third coil operates at 930° to 1100°F. (499° to 593°C.) on about the same type of oil. Is the 900° temperature or the 1100° temperature right? One is wrong.

Pupil: What does the book say? I have as yet to find out where you are supposed to get the right temperature. We are all just guessing.

Pupil: It seems as though there is a lot of guessing—900° to 1100° and take the cut at almost the same point.

Pupil: You establish the time and temperature curve and then fit it so that the maximum temperature will be the transfer rates that are permissible. If you can stand higher transfer rates, you can go to higher temperature.

Pupil: You mean use the highest transfer rate you can?

Pupil: Yes.

Pupil: And then when you get in the cracking range, you can choose the time and that controls the temperature?

Pupil: Yes.

Leader: How are you going to get maximum 70-octane out of the charge at 900°F.?

Pupil: We established three cracks per pass. For light oil we used 23 percent crack per pass because it is the figure Sachanen uses. For recycle oil 20 percent, 10 percent for raw oil, and the composite was 23 percent. Crack per pass in the coking heater was 5 percent, about the maximum for that type of oil. (References are Sachanen, pp. 134 and 225.)

Leader: Doesn't the crack per pass control the amount of recycle material?

Pupil: Very definitely.

2nd Pupil: The raw charge going through the first heater has no recycle at all—15 percent is taken out; there is a 2½ to 1 recycle ratio on the gas-oil heater taking off 23 percent crack per pass. The coking heater has a recycle ratio of 2; this makes it come out about 70 percent of combined gasoline yield by volume. We established the percentage of crack per pass and then figured the recycle ratio necessary to set up that type of yield on the basis of a 10,000-bbl. charge.

Leader: In regard to the temperature, as we discussed it, by temperature we infer both time and temperature, do we not?

Pupil: We didn't attempt to set any time and temperature together — we just took temperature figures based on what we could find, on commercial installations.

Leader: If you were designing a furnace, what would be your idea on building it so that you could vary the time and temperature for the best operation? How would you go about that?

Pupil: We figured on an equiflux heater with sections for individual control of each coil. Permissible heat transfer and temperature gradients that appear desirable will determine the length of the coil and the flow arrangement.

Leader: I regret very much that we can't go into this in greater detail, but if we are going to finish the job, we have to be going on. It really would be helpful if we could spend a complete lesson on going through the various calculations on this unit. I don't know, however, whether you want to spend another night on it or not.

Pupil: If we care to do so, we could spend the rest of our time on cracking and never find a place to stop.

Leader: There has been a sufficient time allotted to this work so that each group has had a certain amount of time for trying his hand at these calculations, and if we failed to bring them up at class, it doesn't mean the individual hasn't had the opportunity, so that next week we shall discuss naphtha reforming, beginning on page 169 of the text. It would be my opinion that we should consider covering thermal and catalytic processes together. In connection with naphtha reforming, why don't we attempt to cover the strictly thermal treatment of all materials, naphtha and lighter? That will be pages 169 to 186, inclusive.

Class Meeting No. 8

Leader: We have a question tonight that should be answered and one group has volunteered to supply an answer, but I should appreciate it very much if the rest would give your versions, if you do not have the same idea. The question is: What distinction is there between polymerization and condensation? What is your understanding of polymerization?

Pupil: We discussed that. One of the members in our group did some very expert research work on this particular question and I would like for him to answer it. One definition of polymerization might be: "Two or more molecules bonding themselves and forming a product that may or may not form water."

Leader: Do these molecules need to be alike?

Pupil: No, they do not. The authority on that is Norris' *Principles of Organic Chemistry*. It is stated that water was always given off in the condensation reaction and not in polymerization.

2nd Pupil: Norris says with or without the elimination of water.

3rd Pupil: Conant in his text confines polymerization to hydrocarbons.

Leader: What does he say about water?

Pupil: He didn't say.

2nd Pupil: I should like to ask whether anyone looked it up in the chemical dictionary.

3rd Pupil: Yes, I did. Polymerization is the combining of two different molecules having the same molecular weights.

Leader: Shall we say the combining of identical molecules?

Pupil: If you had a molecule of butene and a molecule of pentene, it would still be polymerization. I believe they are not identical, but they are similar.

Leader: Who will volunteer a definition of condensation?

Pupil: Norris in *Principles of Organic Chemistry* says: "Condensation is the union of two or more of the same or different molecules, with or without the elimination of water or some other inorganic compound. The term is usually restricted to include only those reactions in which carbon united with carbon, and compounds are formed that cannot be readily decomposed into the substance or substances from which they were prepared."

Leader: I believe that agrees with Conant's definition. Carbon to carbon is the essential difference.

Pupil: Water is always eliminated in the condensation reaction.

Leader: Polymerization is the joining of like molecules but condensation is the joining of like or unlike molecules by means of a carbon-to-carbon bond.

Pupil: How do you account for the water separated in the Dubbs separator?

Leader: I account for it as being water formed in the reaction.

Pupil: According to Sachanen, hydrogen is formed. In discussing condensation on pages 81 and 82, he gives a formula: $2\,C_6H_6 \rightarrow C_6H_5 \cdot C_5H_5 + H_2$ yielding the diaromatic, diphenyl.

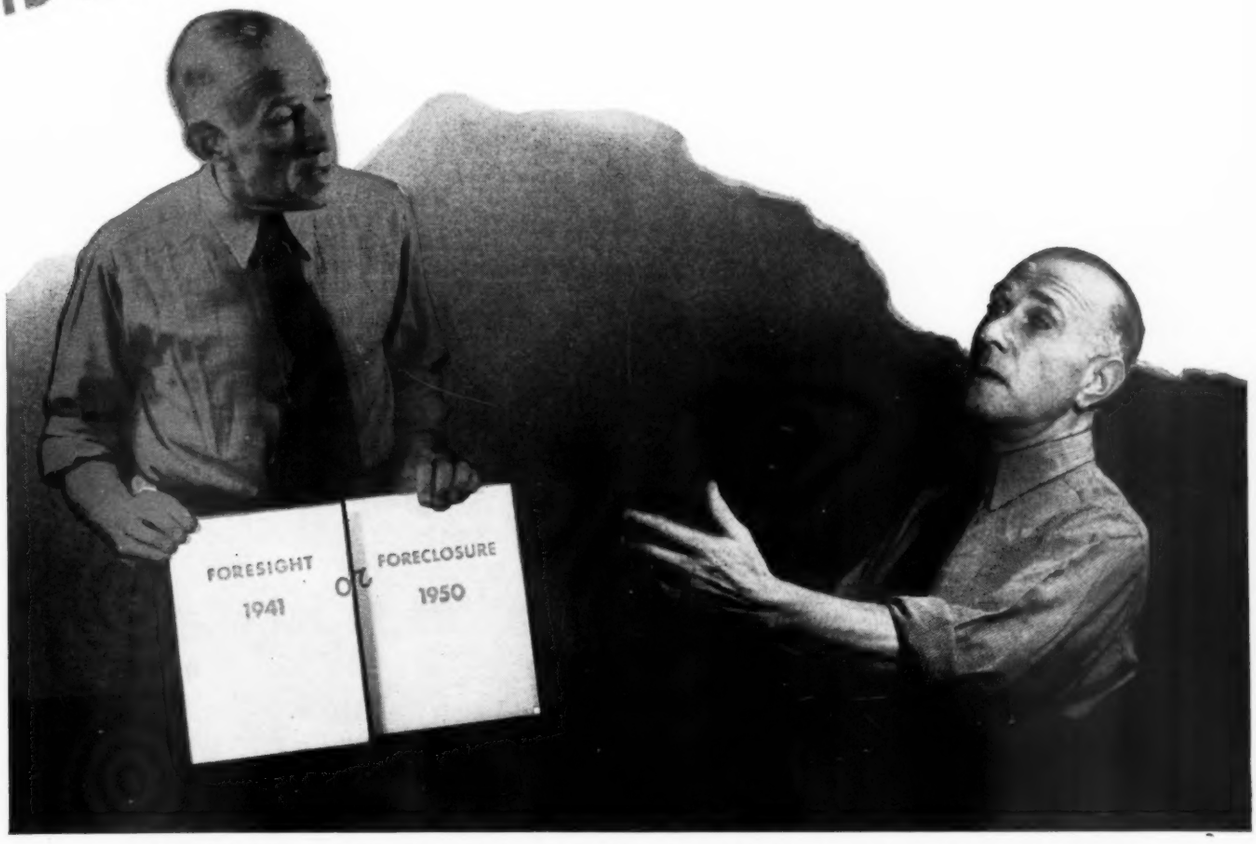
Pupil: Well, he shouldn't always get hydrogen.

Pupil: The author (Sachanen) on page 82 gives several graphic representations of what he calls condensation and he always gets hydrogen. If that would always work on a big scale, he really would have something. He always gets an aromatic carbon of greater molecular weight.

Leader: Well, I think we can consider that as a probability on a small scale only.

(EDITOR'S NOTE: Class meeting No. 8 will be continued in an early issue of *The Petroleum Engineer.*)

I'd RATHER BE RIGHT THAN BE LEFT



ALTER EGO: Literally, "one's other self"—the still, small voice that questions, inspires, and corrects our conscious action.

Sure there's going to be some scrambling when we get back on a 40-hour week. It will be time enough then *to consider whether we'd be right in changing to arc welding.*

ALTER EGO: There won't be time enough then to even consider what hit us.

You mean it will take us a long time to get into welding production?

ALTER EGO: I mean it has taken us far too long already to get into welding *prediction*. Prediction as to what will happen to designs and production methods now that all our friends are going great guns with welding for land, sea and air equipment.

There's no doubt about it, they're getting well up in the welding art.

ALTER EGO: Yes, they're learning the knack in the nick of time. And if we don't have the foresight to get into this *right* away—we'll be *left*, holding the bag . . . on which the closure is foreclosure.

• •

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Multicolumn Fractionation in the Natural Gasoline Industry

PART 3 (Concluded)

by F. D. Parker

Research Supervisor, Union Oil Company of California

A photograph and biographical sketch of the writer can be found on page 130 of the Annual Number (July 1) of The Petroleum Engineer, in connection with Part 1 of this article.

OF THE three processes enumerated at the end of Part 2, Nos. 1 and 3 in general are the most desirable procedures from the point of view of heat requirements and size of equipment. Selection, however, then depends to a large extent on the composition of the wild gasoline and the capacity of the stabilizing equipment. In the third method, the easy separations are made in the presence of lighter and heavier components (which, as pointed out, makes the separation somewhat more difficult) and the difficult separations (*iso*butane from normal butane and *iso*pentane from normal pentane) are made under as favorable conditions as possible with respect to pressure and presence of non-key components.

No. 1 proposal is only questionable in that *iso*butane and normal butane are separated in the presence of material heavier than normal butane, making the separation somewhat more difficult than in the case of No. 3 proposal. No. 1 proposal, however, eliminates the double distillation on *iso*butane with its consequent heat load.

No. 2 proposal makes the difficult *iso*butane-normal butane split in the presence of non-key components both lighter than *iso*butane and heavier than normal butane. The reflux ratio required for this separation is about 7-9 based on the overhead compared to 5-6 for the *iso*butane-normal butane split when made alone, both in 50-plate towers. In addition, No. 2 proposal requires the distillation of propane twice, once as an incidental to the *iso*butane-normal butane split, and once in the depropanizing of the *iso*butane.

Mechanical Capacity

Table 3 presents a compilation of data on stabilizers and fractionators operating at or near their maximum capacity. The data presented include vapor loads expressed in terms of lb. per hr. per sq. ft. of column cross-sectional area and liquid velocities at flow conditions in the downspouts. The maximum permissible mass velocities for each of the columns as calculated by the Brown equation are also presented. The Brown equation is:

$$W = C\,[d_v(d_l - d_v)]^{1/2}$$

in which

W = maximum allowable mass velocity of vapors in the column expressed as lb. per hr. per sq. ft. of cross-sectional area.

C = a constant, which is a function of plate spacing and surface tension of the liquid in the column.

d_v = density of the vapor at the point in the column under consideration.

d_l = density of the liquid under flow-conditions at the point in the column in question.

Both d_v and d_l in the above equation are expressed in terms of lb. per cu. ft.

This equation was presented in *Industrial and Engineering Chemistry* (January, 1934) and has been widely used in the oil industry for the determination of proper column size for various separations. The equation is a generalization derived from actual data on fractionating towers ranging from high-pressure absorbers to vacuum columns, operating under conditions such that appreciable entrainment was occurring. Entrainment is of significance in such places as in lubricating oil distillation where entrainment of heavier cuts may produce undesirable color in the distillate, in gasoline redistillation where entrainment of heavy material from the lower parts of the column may result in inability to meet end-point specifications and/or high gums, and in certain natural gasoline absorbers where high entrainment may result in excessive loss of absorption oil. In actual natural gasoline stabilization and fractionation, however, entrainment is generally not of appreciable importance, and for this reason the Brown equation may give values of column diameter that are quite conservative. In Table 3, columns known to be operating satisfactorily show mass velocities 20-40 percent greater than the allowable mass velocity indicated by the Brown equation. This is especially true at lower pressures and higher plate spacings.

The above data are predicated on the assumption that we are dealing with a reasonably well-designed column, that is, one in which there are not obvious constrictions of either vapor or liquid flow. In general, with bubble-cap columns, the above data will apply provided vapor riser area and total bubble-cap slot area are not less than 8 percent of free cross-sectional area of the column. A secondary proviso is that the bubble-cap slot submergence, as determined by the weight of the outlet weir on the plate, should not exceed approximately 2 in.

A safe figure for liquid velocities in downspouts is 0.5 ft. per second maximum. This is figured on liquid of density corresponding to column temperature at the point in question. It should be borne in mind that under most conditions the actual material flowing in the downspouts is not a true liquid but something of a foam consisting of liquid and entrapped gas, all or a portion of which gas escapes before the liquid reaches the bottom of the downspouts. In dealing with liquids with a tendency to foam, downspouts should be very generously designed. For light hydrocarbons, however, the velocity figure given is an acceptable value.

Operation of Fractionators

1. Flow rate—In general it may be stated that the principal factor with respect to flow rate in the operation of multicolumn fractionators is that rates of all streams should be maintained as constant as possible. When changes are required, they should be gradual.

There are many ways of controlling flow, and in multicolumn fractionation most of these are applied to the control of liquid streams, such as tower feed, reflux, product withdrawal overhead, and bottoms transfer. For example, the feed rate of wild natural gasoline to the No. 1 tower in a multicolumn fractionator set-up is generally established by a flow recorder controller instrument. This consists almost universally of an orifice plate, flanges, and a manometer that measures the flow of feed to the tower. The control instrument proper acts through pneumatic transmission to a control valve that holds the rate at a predetermined value. In the case of feed pumps of the centrifu-

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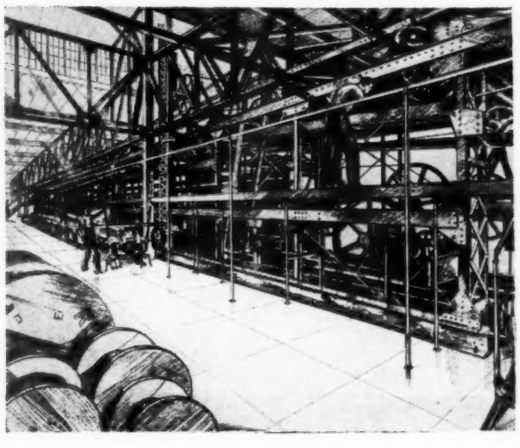

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TABLE 3

Mechanical capacity of stabilizers and fractionators

	Unit 87 Test 2/5/40		Unit 87 Test 2/24/40		Unit 87 Test 2/24/40		Unit 87 1/2/40		Unit 87 3/5/40		Depentanizer 9/11/40 Case 1		Depentanizer Unit 101 9/17/40 Case 11		De-isobutanizer 12/19/40 Unit 103		De-isobutanizer 8/30/40 Unit 101	
	Found by Test	Theoretical by Brown's Equation	Found by Test	Theoretical by Brown's Equation	Found by Test	Theoretical by Brown's Equation	Found by Test	Theoretical by Brown's Equation	Found by Test	Theoretical by Brown's Equation	Found by Test	Based on Brown's Equation	Found by Test	Based on Brown's Equation	Found by Test	Based on Brown's Equation	Found by Test	Based on Brown's Equation
A. Column																		
1. Diameter, ft.	5		5		5		5		5		3		3		6		6	
2. Cross-section area, sq.ft.	19.7		19.7		19.7		19.7		19.7		7.1		7.1		28.3		28.3	
3. Plate spacing, in.																		
a. Rectifying	18		9-13 30" 13-14 36"		14-45 18"		13-14 36" 14-45 18"		13-14 36" 14-45 18"		24		24		24		24	
b. Stripping	18		30		30		30		30		24		24		24		24	
4. Type of plate	Bubble cap		Bubble cap		Bubble cap		Bubble cap		Bubble cap		Perf.plant 1-23 Bubble cap 24		Perf.plate 1-23 Bubble cap 24		Perf.plate 1-1b Bubble cap 1b-50		Perf.plate 1-1b Bubble cap 1b-50	
5. Trays, % of column cross-section in:																		
a. Vapor risers	8.59		8.59		8.59		8.59		8.59		6.9		6.9		11		11	
b. Slots of cap											8.55		8.55		13.7		13.7	
c. Perforations											5.1 trays 1-12 4.65 " 12-23		5.1 trays 1-12 4.65 " 12-23		8.84		8.84	
B. Maximum Loaded Tray, Above Feed																		
1. Tray No.	30		30		30		30		30				-		-		-	
2. Vapor:																		
a. Density, lb./cu.ft.	3.6		3.43		3.00		3.66		3.42		0.537		0.570		1.32		1.34	
b. Rate:																		
1'. Mass velocity, lb./hr./sq.ft.	3,080	3,810	1,855	3,330	1,570	3,340	1,960	3,640	2,560	3,530	1,338	1,820	1,335	1,870	3,540	2,690	3,890	2,710
2'. Superficial velocity, ft./sec.																		
a'. Through column	0.236		0.134		0.145		0.149		0.218		0.692		0.650		0.742		0.806	
b'. Through vapor risers	2.54		1.43		1.54		1.59		4.33									
c'. Through slots																		
d'. Through perforations											13.5		12.75		8.4		9.13	
3. Liquid																		
a. Density, lb./cu.ft.	28.7		28.2		28.2		28.2		28.2		38.8		39.0		35.3		35.3	
b. Mass velocity, lb./hr. sq.ft.	2,980		1,330		1,600		1,480		1,780		1,150		1,120		3,080		3,310	
c. Downspout velocity, ft./sec.	0.37		0.15				0.20		0.26		0.0824		0.0786		0.258		0.736	
C. Maximum Loaded Tray, Below Feed																		
1. Tray No.	3		3		3		3		3		-		-		-		-	
2. Vapor																		
a. Density, lb./cu.ft.	3.74		3.57		3.25		3.35		3.89		0.857		0.561		1.49		1.38	
b. Rate:																		
1'. Mass velocity, lb./hr./sq.ft.	3,310	3,280	3,300	3,810	3,360	3,810	3,670	3,990	4,180	4,220	2,390	2,640	1,660	1,920	4,038	2,960	3,830	2,810
2'. Superficial velocity, ft./sec.																		
a'. Through column	0.246		0.257		0.303		0.304		0.298		0.773		0.824		0.750		0.770	
b'. Through vapor risers	2.62		2.74		3.25		3.24		3.17		11.2(Pl 24) 9.05(Pl 24) 16.6 (Pl 13-23)		11.9(Pl 24 9.62) 17.7 (Pl 13-23)		6.39		0.695	
c'. Through slots															5.45		0.570	
d'. Through perforations																		
3. Liquid																		
a. Density, lb./cu.ft.	25		31.2		31.2		31.1		32.4		44.1		41.5		38.0		36.9	
b. Rate:																		
1'. Mass velocity, lb./hr./sq.ft.	4,130		6,026		6,740		6,760		6,350		2,460		1,880		4,420		4,130	
2'. Downspout velocity, ft./sec.	0.58		0.52		0.59		0.61		0.66		0.0211		0.125		0.344		0.330	

TABLE 3 (Continued)

Mechanical capacity of stabilizers and fractionators

	Depropanizer Unit 1-1 8/14/40		Unit 87 Test 10/24/40 6 a.m.		Unit 87 Test 10/24/40 Midnight		Unit 87 10/26/40 Noon		Unit 87 May 7-11, 1940		Unit 87 May 11-15, 1940		Unit 87 Test May 21, 1940 2 a.m.		Unit 87 Test June 1, 1940 2 a.m.		Experimental Alcohol-water Column Found by Test			
	Found by Test	Based on Brown's Equation	Found by Test	Based on Brown's Equation	Found by Test	Based on Brown's Equation	Found by Test	Based on Brown's Equation	Found by Test	Based on Brown's Equation	Found by Test	Based on Brown's Equation	Found by Test	Based on Brown's Equation	Found by Test	Based on Brown's Equation				
A. Column																				
1. Diameter, ft.	4		5		5		5		5		5		5		5		1.96			
2. Cross-section area, sq.ft.	12.6		19.7		19.7		19.7		19.7		19.7		19.7		19.7		3.01			
3. Plate spacing, in.																				
a. Rectifying	18		18		18		18		18		18		18		18		6 to 18			
b. Stripping	24		18		18		18		18		18		18		18					
4. Type of plate	Perf.Plate		Bubble cap		Bubble cap		Bubble cap		Bubble cap		Bubble cap		Bubble cap		Bubble cap		Bubble cap			
5. Trays, % of column cross-section in:																				
a. Vapor risers			8.59		8.59		8.59		8.59		8.59		8.59		8.59		4.68			
b. Slots of cap																	5.47			
c. Perforations	3.28% Pl. 1-19 4.75% Pl. 20-35																			
B. Maximum Loaded Tray, Above Feed																	Loading is at capacity at plate spacing shown and 1" of liquid			
1. Tray No.																	Plate Spacing			
2. Vapor:																	6"	12"	18"	18"a
a. Density, lb. c..ft.	1.97		3.58		2.52		2.57		2.88		2.82		2.72		2.73		0.087	0.087	0.087	0.087
b. Rate:																				
1'. Mass velocity, lb./ hr. sq.ft.	1,340	3,070	1,830	3,880	2,530	3,640	2,390	3,870	1,230	3,880	1,150	3,660	2,160	3,780	2,250	3,780	423	659	1,410	2,040
2'. Superficial velocity, ft./sec.																				
a'. Through column	0.189		0.142		0.278		0.258		0.121		0.113		0.221		0.279		1.35	2.10	4.5	6.5
b'. Through vapor risers			1.86		3.24		3.01		1.41		1.32		2.57		2.67		27.5	42.7	91.5	132.8
c'. Through slots																	23.3	36.2	77.6	112.3
d'. Through perforations	0.712																577		1,150	
3. Liquid																	Mass velocity according to Brown's Equation			
a. Density, lb./cu.ft.	31.7		31.4		35.3		35.3		35.3		35.6		35.0		35.3					
b. Mass velocity, lb./hr./sq.ft.	1,090		1,460		1,930		2,020		676		745		586		2,210					
c. Downspout velocity, ft./sec.	0.101		0.1630		0.197		0.20		0.0674		0.0734		0.0586		0.220					
C. Maximum Loaded Tray, Below Feed																				
1. Tray No.																				
2. Vapor																				
a. Density, lb./cu.ft.	2.78		3.65		3.55		3.49		3.53		3.60		3.44		3.42					
b. Rate																				
1'. Mass velocity, ft./sec.	2,250	3,860	731	4,430	2,700	4,660	2,490	4,800	2,190	4,580	1,800	4,610	3,170	4,520	3,070	4,530				
2'. Superficial velocity, ft./sec.																				
a'. Through column	0.228		0.0556		0.212		0.265		0.172		0.139		0.256		0.250					
b'. Through vapor risers			0.648		2.46		3.09		2.0		1.62		2.98		2.90					
c'. Through slots																				
d'. Through perforations	4.80																			
3. Liquid																				
a. Density, lb./cu.ft.	38.2		37.0		40.1		41.2		40.4		41.5		40.0		40.8					
b. Rate:																				
1'. Mass velocity, lb./hr./sq.ft.	3,840		1,375		4,680		4,400		3,460		3,170		4,720		4,410					
2'. Downspout velocity, ft./sec.	0.0291		0.130		0.410		0.375		0.301		0.278		0.415		0.378					

a. With 10-15% entrainment.

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Wherever these forged-steel gates go in . . . on field and refinery lines up to 2" . . . new fields of valve-performance are opened up. For Chapman 960 "squeezes off" the usual small-valve troubles and repairs, and produces nothing but top-grade, uninterrupted service, under all conditions.

This big value in small valves lasts longer . . . *therefore costs less* . . . than any similar valve for general oil industry service. Specially hardened stainless steel gives exceptionally long life to the interchangeable rising stem, seat-rings and wedge. And threads won't stick because they're quick-acting . . . always turn easily *on the first turn*. List 960 is good for pressures up to 800 lb. at 750° F., and for cold working pressures up to 1500 lb. You can get any size you need from the Chapman plant, or through the nearest Chapman office. WRITE.

LIST 960 "PAYS OFF" WITH THESE FEATURES:

1. Replaceable stainless steel parts... super-hardened.
2. Flexible stem connection
3. Quick-acting threads
4. All threads inside the valve
5. Full-pressure repacking
6. Ball joint connection

THE CHAPMAN VALVE
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INDIAN ORCHARD, MASS.

Summary of Gasoline Fractionation

Description	1 Stabilizer Net Feed	1 Stabilizer Net Overhead	1 Stabilizer Net Bottoms	2 Stabilizer Net Feed	2 Stabilizer Net Overhead	2 Stabilizer Net Bottoms	3 Natural Gasoline Net Feed	3 Natural Gasoline Net Overhead	3 Natural Gasoline Net Bottoms	4 Propane-Butane-Pentane Net Feed	4 Propane-Butane-Pentane Net Overhead	4 Propane-Butane-Pentane Net Bottoms	5 Underwood's Example Net Feed	5 Underwood's Example Net Overhead	5 Underwood's Example Net Bottoms	6 Stabilizer Fractionation No.1 Net Feed	6 Stabilizer Fractionation No.1 Net Overhead	6 Stabilizer Fractionation No.1 Net Bottoms	7 Stabilizer Fractionation No.2 Net Feed	7 Stabilizer Fractionation No.2 Net Overhead	7 Stabilizer Fractionation No.2 Net Bottoms
Components (mol per cent)																					
H_2																0.47	0.474				
CH_4	0.02	0.0611														0.28	0.573	0.0366	0.0366	0.08	
C_2H_4																0.25	0.044	0.421	0.421	0.90	0.017
C_2H_6	0.30	0.316		0.0384	0.21											0.12	0.006	0.217	0.212	0.02	0.375
C_3H_6	0.08	0.19														0.13		0.238	0.238		0.440
C_3H_8	0.125	0.39	0.0025	0.189	0.427	0.0009	0.13	0.497	0.01	0.3	0.9399	0.0172				0.01		0.055	0.055		0.101
$i\text{-}C_4H_{10}$	0.035	0.022	0.041																		
$n\text{-}C_4H_{10}$	0.150	0.019	0.211	0.384	0.113	0.481	0.30	0.513	0.309	0.35	0.0600	0.4873				0.07		0.244	0.0366		0.067
C_5H_{12}	0.152		0.222	0.241		0.311	0.55	0.020	0.781	0.35		0.50									
C_6H_{14}	0.111		0.165	0.128		0.197							0.31	0.536							
C_7H_{16}	0.090		0.132										0.266	0.46	0.00134						
C_8H_{18}	0.085		0.124										0.187	0.004	0.437						
C_9H_{20}													0.125		0.294						
$C_{10}H_{22}$ 360+F.	0.070		0.102										0.112		0.264						
Key Components																					
Light key		C_3H_8			C_3H_8			C_3H_8			C_3H_8			C_7H_{16}			CH_4			C_2H_6	
Heavy key		$n\text{-}C_4H_{10}$			C_4H_{10}			C_4H_{10}			C_4H_{10}			C_8H_{18}			C_2H_6			C_3H_8	
Relative volatility $\alpha = \frac{K_{LK}}{K_{HK}}$	α at 340 lb. abs. and 150°F. = 2.45			α at 290 lb. and 150°F. = 1.95			α at 150 lb. gs. and 150°F. = 4.8			α at 250 lb. and 150°F. = 2.5			α at 15 lb. and 180°F. = 2.08			α at 600 lb. and 120°F. = 6.9			α at 300 lb. and 180°F. = 1.4		
Material Balance																					
Basis: 100 mols of feed																					
Feed		100			100			100			100			100			100			100	
Overhead		31.6			47.8			36			50			51.8			95.4			45.9	
Bottoms		68.4			52.9			64			50			48.2			54.6			54.1	
Key Component Recovery																					
% light key component in overhead		98.5			99.6			93.6			96.0			99.9			92.9			98.3	
% heavy key component in bottoms		78.1			91.9			99.5			98.8			98.8			96.6			95.4	
Reflux Ratio-Plate Relationship																					
L/D or L'/D above feed plate	(0.53[a] (0.76[b]	2.0[a] 2.0[b]	∞[a] ∞[b]	2.36	2.37	∞	1.5	5.47	9.0	∞	1.85	9	∞	0.9	3	∞	0.78	0.9	2.0	∞	3.3	4.0	6.0	10.0	∞
L/V below feed																					
Theoretical plates	(∞[a] (∞[b]	11[a] 13[b]	7.4[a] 9.2[b]	∞	25.8	9.8	∞	8.5	7.8	6.7	∞	9.5	7.4	∞	16	13.0	∞	8.0	3.4	1.4	∞	37	28	23	17.7
$\frac{(L/D)-(L/D)_m}{(L/D)+1}$	(0 (0	0.408 0.414[b]	1.0[b] 0.322	0	0.087	0.555	0	0.425	0.75	1.0	0	0.715	1.0	0	0.525	1.0	0	0.063	0.407	1.0	0	0.14	0.386	0.809	1.0
$\frac{N-N_m}{N+1}$	(1.0[a] (1.0[b]	0.357[a] 0.322[b]	0[a] 0	9.8	1.0	0	1.0	0.371	0.11	0	1.0	0.165	0	1.0	0.332	0	1.0	0.6	0.333	0	1.0	0.483	0.332	0.804	0

a. For Case A cold feed.
b. For Case B same as Case A except recovery of nC_4 was 99% instead of 96%.

Summary of Gasoline Fractionation (Continued)

Description	8 Depentanizer No. 1 Net Feed	8 Depentanizer No. 1 Net Overhead	8 Depentanizer No. 1 Net Bottoms	9 Depentanizer No. 2 Net Feed	9 Depentanizer No. 2 Net Overhead	9 Depentanizer No. 2 Net Bottoms	10 Debutanizer 10/24/40 4 a.m. Net Feed	10 Debutanizer 10/24/40 4 a.m. Net Overhead	10 Debutanizer 10/24/40 4 a.m. Net Bottoms	11 Debutanizer 10/24/40 Midnight Net Feed	11 Debutanizer 10/24/40 Midnight Net Overhead	11 Debutanizer 10/24/40 Midnight Net Bottoms	12 Debutanizer 10/26/40 Noon Net Feed	12 Debutanizer 10/26/40 Noon Net Overhead	12 Debutanizer 10/26/40 Noon Net Bottoms	13 Debutanizer Average May 7-16, 1940 Net Feed	13 Debutanizer Average May 7-16, 1940 Net Overhead	13 Debutanizer Average May 7-16, 1940 Net Bottoms
Components (mol per cent)																		
H_2																		
CH_4										0.0005	0.00166		0.00042	0.00172		0.00071	0.00235	
C_2H_4																		
C_2H_6							0.0042	0.0146		0.00506	0.0169		0.00404	0.0191		0.00496	0.0194	
C_3H_6																		
C_3H_8							0.1033	0.360		0.101	0.336		0.0931	0.392		0.0749	0.290	
$i\text{-}C_4H_{10}$	0.083	0.181	0.0167	0.0302	0.078		0.0761	0.107	0.031	0.0744	0.232	0.0073	0.0931	0.280	0.0115	0.1305	0.380	0.0161
$n\text{-}C_4H_{10}$	0.453	0.582	0.434	0.341	0.49	0.007	0.290	0.480	0.418	0.249	0.415	0.1787	0.249	0.439	0.230	0.262	0.378	0.000
$i\text{-}C_5H_{12}$	0.180	0.238	0.140	0.100	0.132	0.078												
$n\text{-}C_5H_{12}$																		
C_6H_{14}																		
C_7H_{16}																		
C_8H_{18}																		
(Res) C_9H_{20}	0.482		0.812	0.559		0.915	0.586		0.194	0.571		0.815	0.559		0.737	0.560		0.728
$C_{10}H_{22}$ 360+F.																		
Key Components																		
Light key		$1\text{-}C_5H_{12}$			$1\text{-}C_5H_{12}$			$1\text{-}C_4H_{10}$			$1\text{-}C_4H_{10}$			$n\text{-}C_4H_{10}$			$1\text{-}C_4H_{10}$	
Heavy key		$n\text{-}C_5H_{12}$			$n\text{-}C_5H_{12}$			$n\text{-}C_4H_{10}$			$n\text{-}C_4H_{10}$			$n\text{-}C_4H_{10}$			$n\text{-}C_4H_{10}$	
Relative volatility $= \frac{K_{LK}}{K_{HK}}$	α at 1 atm. and 200°F. = 1.16			α at 1 atm. and 200°F. = 1.16			α at 265 lb./sq.in.abs. and 185°F. = 1.26			α at 265 lb. 185°F. = 1.26			α at 265 lb. 185°F. = 1.26			α at 265 lb. 185°F. = 1.26		
Material Balance																		
Basis: 100 mols of feed																		
Feed		100			100			100			100			100			100	
Overhead		59.4			38.8			28.8			29.8			24.3			24.5	
Bottoms		41.6			61.2			71.2			70.2			75.7			74.5	
Key Component Recovery																		
% light key component in overhead		92.5			98.7			79.5			93.4			71.0			97.5	
% heavy key component in bottoms		40.3			47.9			49.7			50.2			69.8			81.5	
Reflux Ratio-Plate Relationship																		
L/D or L'/D above feed plate		0.25			1.7			1.28			1.82			4.83			1.52	
L/V below feed		1.21			1.18			1.33			1.66			1.84			1.98	
Theoretical plates	Actual plates = 24			Actual plates = 24			Actual plates = 50			Actual plates = 50			Actual plates = 50			Actual plates = 50		
$\frac{(L/D)-(L/D)_m}{(L/D)+1}$																		
$\frac{N-N_m}{N+1}$																		
Mass velocities	Top Section lb./hr./sq.ft.	Bottom Section lb./hr./ Feet	Feet	sq.ft.	Top Section lb./hr./sq.ft.	Bottom Section lb./hr./ Feet	Feet	sq.ft.	Top Section lb./hr./sq.ft.	Bottom Section lb./hr./ Feet	Feet	sq.ft.	Top Section lb./hr./sq.ft.	Bottom Section lb./hr./ Feet	Feet	sq.ft.	Top Section lb./hr./sq.ft.	Bottom Section lb./hr./ Feet	Feet	sq.ft.
Calculated	3,840	3.6	2.0	4,430	3,840	4.2	3.0	4,660	3,670	4.0	3.0	4,600	3,380	2.8	3.2	4,350
Actual	3,840	5.0	3.0	7,300	2,530	5.0	3.0	4,700	2,274	5.0	3.0	2,450	1,250	5.0	5.0	2,150

Summary of Gasoline Fractionation (Continued)

Description	14 Debutanizer May 15, 1940 7 a.m. Net Feed	14 Debutanizer May 15, 1940 7 a.m. Net Overhead	14 Debutanizer May 15, 1940 7 a.m. Net Bottoms	15 Debutanizer Average May 13-16, 1940 Net Feed	15 Debutanizer Average May 13-16, 1940 Net Overhead	15 Debutanizer Average May 13-16, 1940 Net Bottoms	16 Debutanizer June 11, 1940 4 a.m. Net Feed	16 Debutanizer June 11, 1940 4 a.m. Net Overhead	16 Debutanizer June 11, 1940 4 a.m. Net Bottoms	17 Debutanizer Unit 101 Alkylation Plant Test September 13, 1940 Net Feed	17 Debutanizer Unit 101 Alkylation Plant Test September 13, 1940 Net Overhead	17 Debutanizer Unit 101 Alkylation Plant Test September 13, 1940 Net Bottoms	18 Depropanizer Unit 101 Alkylation Plant Test August 14, 1940 Net Feed	18 Depropanizer Unit 101 Alkylation Plant Test August 14, 1940 Net Overhead	18 Depropanizer Unit 101 Alkylation Plant Test August 14, 1940 Net Bottoms	19 De-isobutanizer Unit 101 Alkylation Plant Test August 14, 1940 Net Feed	19 De-isobutanizer Unit 101 Alkylation Plant Test August 14, 1940 Net Overhead	19 De-isobutanizer Unit 101 Alkylation Plant Test August 14, 1940 Net Bottoms
Components (mol per cent)																		
H_2																		
CH_4	0.000407	0.0017					0.0613	0.0054										
C_2H_4																		
C_2H_6	0.00424	0.018		0.00146	0.0114		0.0049	0.0192										
C_3H_6													0.0118	0.051				
C_3H_8	0.118	0.493		0.0765	0.251		0.0805	0.316		0.0075	0.0108		0.0091	0.035	0.0002			
$i\text{-}C_4H_{10}$	0.118	0.314	0.0536	0.1058	0.272	0.0179	0.113	0.400	0.016	0.897	0.971	0.0302	0.227	0.914	0.0276	0.0087	0.0128	
$n\text{-}C_4H_{10}$	0.233	0.574	0.255	0.242	0.465	0.145	0.241	0.260	0.215	0.157	0.0185	0.4986	0.173		0.2235	0.6437	0.9274	
$i\text{-}C_5H_{12}$										0.0715		0.245	0.412		0.5320	0.2385	0.0600	0.6434
$n\text{-}C_5H_{12}$													0.082		0.1064	0.0437		0.1428
C_6H_{14}													0.0852		0.1103	0.0179		0.0520
C_7H_{16}																		
C_8H_{18}																		
(Res) C_9H_{20}	0.525		0.672	0.570		0.822	0.581		0.750	0.0662		0.227				0.0495		0.1614
$C_{10}H_{22}$ 360+F.																		
Key Components																		
Light key		$1\text{-}C_4H_{10}$			$1\text{-}C_4H_{10}$			$1\text{-}C_4H_{10}$			$1\text{-}C_4H_{10}$			C_3H_8			$1\text{-}C_4H_{10}$	
Heavy key		$n\text{-}C_4H_{10}$			$n\text{-}C_4H_{10}$			$n\text{-}C_4H_{10}$			$n\text{-}C_4H_{10}$			$1\text{-}C_4H_{10}$			$n\text{-}C_4H_{10}$	
Relative volatility $= \frac{K_{LK}}{K_{HK}}$	α 265 lb. = 1.26 185°F.			α 265 lb. 185°F. = 1.26			α 265 lb. 185°F. = 1.26			1.35			1.81			1.27		
Material Balance																		
Basis: 100 mols of feed																		
Feed		100			100			100			100			100			100	
Overhead		24.0			30.5			25.7			71			24.5			69.4	
Bottoms		76.0			69.5			74.1			29			77.5			30.6	
Key Component Recovery																		
% light key component in overhead		65.0			78.4			89.8			98.5			90.6			100	
% heavy key component in bottoms		82.1			61.6			72.5			92.5			100.0			82.55	
Reflux Ratio-Plate Relationship																		
L/D or L'/D above feed plate		5.62			1.81			6.99			3.74			4.24			5.45	
L/V below feed		1.50			1.75			1.46			1.10			1.36			1.08	
Theoretical plates	Actual plates = 30			Actual plates = 30			Actual plates = 50			Actual plates = 50			Actual plates = 34			Actual plates = 50		
$\frac{(L/D)-(L/D)_m}{(L/D)+1}$																		
$\frac{N-N_m}{N+1}$																		
Mass velocities	Top Section lb./hr./sq.ft.	Bottom Section lb./hr./ Feet	Feet	sq.ft.	Top Section lb./hr./sq.ft.	Bottom Section lb./hr./ Feet	Feet	sq.ft.	Top Section lb./hr./sq.ft.	Bottom Section lb./hr./ Feet	Feet	sq.ft.	Top Section lb./hr./sq.ft.	Bottom Section lb./hr./ Feet	Feet	sq.ft.	Top Section lb./hr./sq.ft.	Bottom Section lb./hr./ Feet	Feet	sq.ft.
Calculated	3,780	3.8	4.8	4,520	3,660	2.8	3.1	4,610	3,780	3.8	4.1	4,530	2,690	6.9	7.6	2,980	3,670	2.7	3.3	3,860	2,710	7.2	7.0	2,810
Actual	2,180	5.0	5.0	1,170	1,150	5.0	5.0	1,800	2,230	5.0	5.0	3,070	1,540	6.0	6.0	1,630	1,340	4.0	4.0	2,250	1,890	6.0	6.0	1,830

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gal type, it is customary to throttle on the discharge side of the pump with a motor valve controlled by the action of the flow recording controller instrument. In the field, where reciprocating steam pumps are used, the motor valve actuated by the flow recorder controller instrument is generally placed in the high-pressure steam line to the steam pump. In the latter case the amount of steam delivered to the pump is under control of the instrument and the speed or r.p.m. of the pump varies according to whether more or less flow of liquid is required to meet the predetermined rate.

The control of the reflux rate is also of prime significance in multicolumn fractionation. The control of this stream is generally identical in principle to that for control of the feed stream. The flow recorder controller manometer is across an orifice plate in the discharge line of the reflux pump. Rate of flow is controlled by throttling with a motor valve in the pump discharge line or by controlling the rate of steam to the pump in case it is a reciprocating steam-driven type.

The rate of bottoms transfer from one tower to a second tower in a series of multicolumn fractionators is usually accomplished by a liquid-level controller.

In the majority of cases it is of much more importance to control rate of flow of bottoms material from the tower than it is to maintain an exact level in that tower. The liquid-level controller in reality acts as a flow controller and utilizes a certain portion of the storage volume available in the bottom of the tower to iron out inequalities in the rate of production of bottoms within the tower. The bottoms are thus produced to the next tower in series in a smooth, continuous stream. Liquid-level controllers employed to transfer bottoms from one tower to another tower in series should have a float with a relatively long travel, so that advantage can be taken of surge volume available. Instrument type or manometer type level controllers may also be used.

2. *Temperature*—In control of multicolumn fractionator plants, temperature is the most widely used control variable.

Temperature within a tower or at the top or bottom of the tower is widely used as a criterion of product quality. For example, in stabilization of natural gasoline to 22-lb. Reid vapor pressure, the operating control employed is almost always temperature at the bottom of the tower.

In the production of essentially pure components or very narrow boiling cuts from natural gasoline, top temperature is not a reliable control. It might be assumed that to produce, for example, *iso*butane as the overhead from a secondary tower of a multicolumn fractionator set-up under a pressure of 100 lb. per sq. in. gauge, that by reference to the vapor pressure chart, we could determine a suitable temperature for the production of virtually pure *iso*butane overhead. In this example the vapor pressure chart indicates the temperature corresponding to pure *iso*butane is 133°F. An attempt to operate with the top of the tower controlled to this temperature at a fixed reflux rate and by varying the reboiler heat input through control of the amount of steam to the reboiler, will produce a product that will vary widely in composition. This is because the top temperature of the tower is the temperature of vapors leaving the tower to be condensed to form the overhead product, the quality of which it is desired to maintain. Should this temperature change, the quality of the *iso*butane being produced overhead to the condenser and hence to the product tank is offgrade. Return of the temperature to the control point returns the overhead production to quality after the damage has been done.

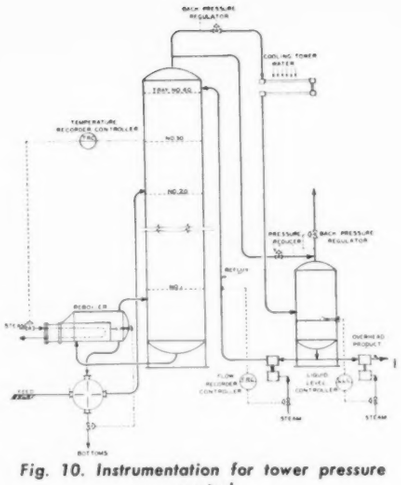

Fig. 10. Instrumentation for tower pressure control

A more satisfactory control for fractionation of this type is to control a temperature within the tower, say, at a point about 10 trays down from the top. This serves in effect as anticipatory control for overhead product quality. That is, heavier material that may appear on the upper trays of the column due, for example, to insufficient reflux, will increase the temperature of the reference plate. By adjusting conditions such as by increasing the reflux or decreasing the amount of steam to the reboiler, the temperature on the tenth plate can be returned to the desired control value and the heavier material washed down the tower before it contaminates the overhead product. The actual point of control is generally determined by trial and error, and should be at a point where the temperature gradient in the tower is relatively steep. The point for temperature control can be located where the sharp temperature gradient of the top trays changes to the relatively constant temperature zone of the fractionating section. When controlling bottoms products, the point of temperature control can be where the relatively sharp gradient for the bottom trays changes to the relatively constant temperature zone of the stripping section.

3. *Pressure*—Pressure is required in certain cases to effect condensation of overhead for the production of reflux with available cooling water temperatures. Pressure is seldom used as a control variable, and is generally established at a certain value and other variables are used for product quality control. For example, stabilizers are generally set to operate at a fixed pressure, and temperature is used as a variable for controlling the vapor pressure of the gasoline product from the bottom. A common installation for towers that are producing a liquid product overhead is an installation of the type sketched in Fig. 10. This involves the use of a back-pressure regulator in the vapor line off the tower and between the tower and the condensers. Thus the tower operating pressure is fixed regardless of variations in the amount of cooling at the condensers.

With the installation of the back-pressure valve in the vapor line off the tower, pressure considerations at the reflux drum are occasionally significant. It is possible with a tower operating as in Fig. 10 for the vapors to be subcooled on condensation. The liquid product in the reflux drum may then have a vapor pressure well below the tower pressure. The reflux pump returns the reflux liquid from the drum to the tower, and the pressure differential to be overcome may exceed that characteristic of the pump. Under these conditions only a small amount or no reflux can be returned to the tower and fractionation is upset. As a means for avoiding this, a so-called "hot overhead bypass line" is generally provided from the upstream side of the back-pressure regulator to the reflux drum without intermediate cooling. This line is equipped with a reducing valve that opens to admit the passage of hot overhead vapor when the pressure in the reflux drum falls below a certain point. Hot gases then pass through the line and are dissolved to a sufficient extent in the reflux drum liquid to increase its temperature and hence its vapor pressure. The pressure-reducing valve then shuts off and the reflux system operates satisfactorily.

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT No. 50

THE tables on the following pages are designed to save time and effort for the technician, and to assist the practical field or plant worker to solve problems commonly encountered in routine work. They are not intended nor expected to supplant technical training and make every man his own designer. Most of the tables can be understood and applied by anyone acquainted with the simple fundamentals of mathematics.

For the convenience of readers who wish to refer to the tables, each page carries in the upper right corner an index number that classifies the table according to subject matter.

All petroleum engineering literature may be indexed for reference according to the Dewey Decimal System as modified and extended for the petroleum industry by L. C. Uren, professor of petroleum engineering at the University of California. When classified according to these index numbers the material follows in a logical sequence and falls into several natural divisions, as illustrated by the following outline:

	No. of Tables (49 Installments)
Nos. P000-P339—General	38
Nos. P400-P499—Drilling	93
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To aid the reader in using the Decimal System, a subject index arranged alphabetically has been published, and is available at a cost of 50 cents per copy from *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas.

INDEX TO TABLES*

Title of Table	*Index No.*	*Page*	*Issue*
Rise in fluid level, etc., due to running 2½-in. external-upset tubing in well fluid	P 511.141.250.1	89	Aug.
Rise in fluid level, etc., due to running 1½-in. non-upset tubing in well fluid	P 511.141.150.2	91	July
Velocity of flow, ft. per sec., through annulus between 1¼-in. and 4-in. tubing (sheet 5B)	P 533.300.125.2	87	Aug.
Velocity of flow, ft. per sec., through annulus between 1½-in. and 4-in. tubing	P 533.300.150.2	89	July
Gravity of dry oil in oil-water mixtures, deg. A.P.I.	P 677.410.301	87	July
Gravity of dry oil in oil-water mixture, deg. A.P.I.	P 677.410.350.1	91	Aug.

*This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue, and 37-48, inclusive, in the June, 1941, issue.

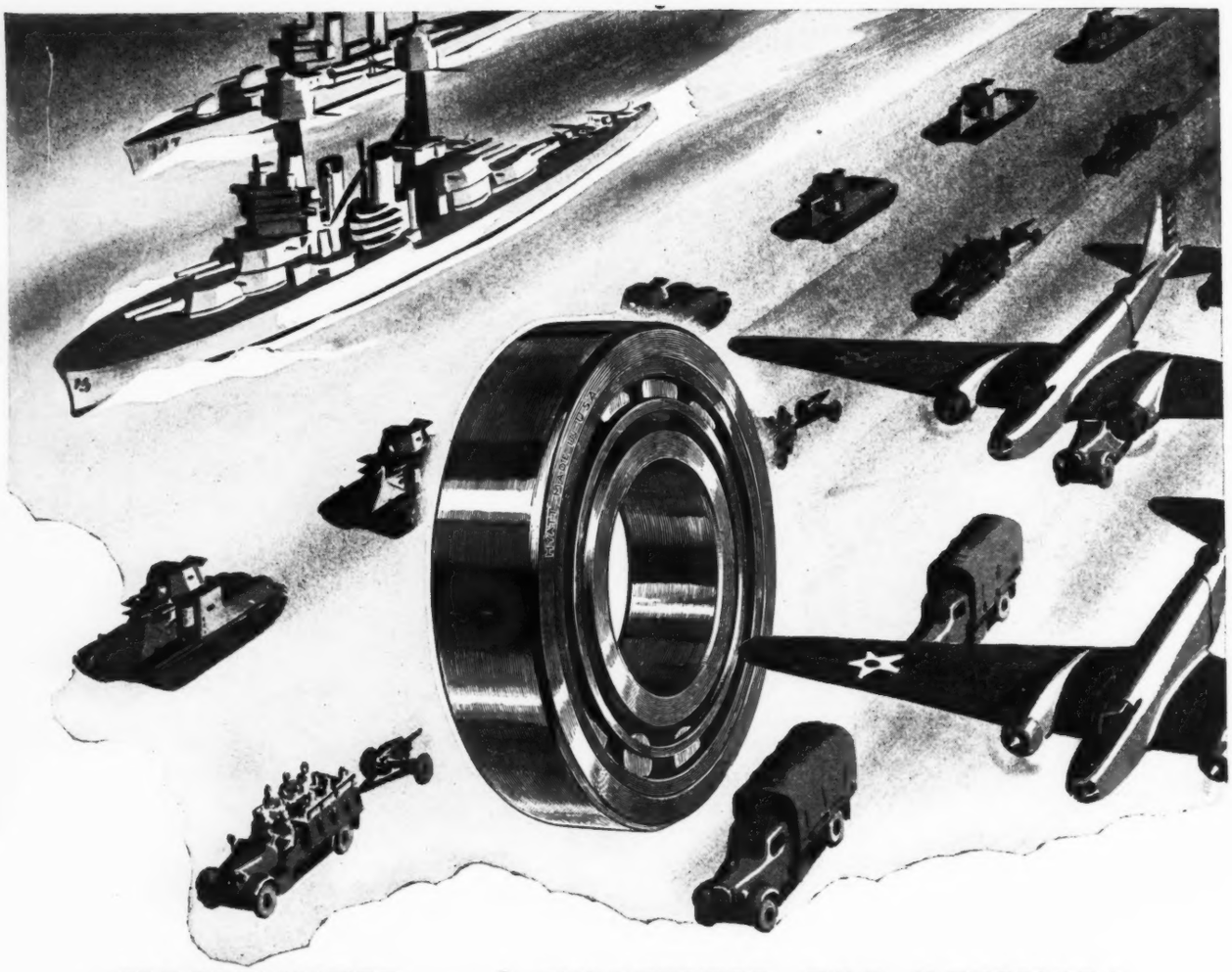
INDEX TO ADVERTISERS IN TABLES

	Page	*Issue*	*Backing Table No.*
Bantam Bearings Corporation	88	July	P 677.410.301
Bantam Bearings Corporation	92	Aug.	P 677.410.350.1
Bethlehem Steel Company (sheet 3B)	90	July	P 533.300.150.2
Hyatt Bearings Division, General Motors Sales Corporation	92	July	P 511.141.150.2
Hyatt Bearings Division, General Motors Sales Corporation	88	Aug.	P 533.300.125.2
Reed Roller Bit Company	90	Aug.	P 511.141.250.1

VELOCITY[1] OF FLOW, FT. PER SEC., THROUGH ANNULUS BETWEEN 1¼-IN. AND 4-IN. TUBING

Rate of production, bbl. per day	Gas-oil ratio, cu. ft. per bbl.	Tubing pressure[2] at casinghead, lb. per sq. in. gauge								
		0	25	50	75	100	125	150	175	200
50	1000	8.4	3.1	1.9	1.4	1.1	0.9	0.8	0.8	0.6
100		16.8	6.3	3.9	2.8	2.2	1.9	1.6	1.5	1.2
150		25.3	9.4	5.8	4.2	3.4	2.8	2.4	2.3	1.9
200		33.7	12.5	7.8	5.7	4.5	3.7	3.2	3.0	2.5
200		42.1	15.6	9.7	7.1	5.6	4.6	4.0	3.8	3.1
300		50.5	18.8	11.7	8.5	6.7	5.6	4.8	4.5	3.7
350		58.9	21.9	13.6	9.9	7.8	6.5	5.6	5.3	4.3
400		67.4	25.0	15.5	11.3	8.9	7.4	6.3	6.0	5.0
50	1250	10.3	3.9	2.6	1.8	1.4	1.1	1.0	0.9	0.8
100		20.6	7.8	5.3	3.5	2.8	2.3	2.0	1.9	1.5
150		31.0	11.7	7.9	5.3	4.2	3.4	2.9	2.8	2.3
200		41.3	15.6	10.5	7.0	5.5	4.6	3.9	3.7	3.1
250		51.6	19.5	13.2	8.8	6.9	5.7	4.9	4.6	3.8
300		61.9	23.4	15.8	10.5	8.3	6.9	5.9	5.6	4.6
350		72.2	27.3	18.5	12.3	9.7	8.0	6.9	6.5	5.3
400		82.6	31.2	21.1	14.1	11.1	9.2	7.8	7.4	6.1
50	1500	12.4	4.7	2.9	2.1	1.7	1.4	1.2	1.0	0.9
100		24.9	9.3	5.8	4.2	3.3	2.7	2.3	2.0	1.8
150		37.3	14.0	8.7	6.3	5.0	4.1	3.5	3.1	2.7
200		49.8	18.7	11.6	8.4	6.6	5.5	4.7	4.1	3.6
250		62.2	23.3	14.5	10.5	8.3	6.8	5.8	5.1	4.5
300		74.7	28.0	17.3	12.6	9.9	8.2	7.0	6.1	5.4
350		87.1	32.7	20.2	14.7	11.6	9.6	8.2	7.1	6.3
400		99.6	37.4	23.1	16.8	13.2	10.9	9.3	8.2	7.2
50	1750	14.4	5.4	3.4	2.4	1.9	1.6	1.4	1.3	1.1
100		28.9	10.9	6.7	4.9	3.8	3.2	2.7	2.6	2.1
150		43.3	16.3	10.1	7.3	5.8	4.8	4.1	3.8	3.2
200		57.8	21.8	13.5	9.8	7.7	6.3	5.4	5.1	4.2
250		72.1	27.2	16.8	12.2	9.6	7.9	6.8	6.4	5.3
300		86.6	32.6	20.2	14.7	11.5	9.5	8.1	7.7	6.3
350		101.0	38.1	23.6	17.1	13.5	11.1	9.5	9.0	7.4
400		115.4	43.5	26.9	19.5	15.4	12.7	10.8	10.2	8.5
50	2000	16.5	6.2	3.8	2.8	2.2	1.8	1.5	1.4	1.2
100		33.0	12.4	7.7	5.6	4.4	3.6	3.1	2.7	2.4
150		49.4	18.6	11.5	8.4	6.6	5.4	4.6	4.1	3.6
200		65.9	24.8	15.4	11.1	8.8	7.2	6.2	5.5	4.8
250		82.4	31.1	19.2	13.9	11.0	9.0	7.7	6.9	6.0
300		98.9	37.3	23.0	16.7	13.1	10.8	9.2	8.2	7.2
350		115.4	43.5	26.9	19.5	15.3	12.7	10.8	9.6	8.4
400		131.9	49.7	30.7	22.3	17.5	14.5	12.3	11.0	9.5
50	2250	18.5	7.0	4.3	3.1	2.5	2.0	1.7	1.6	1.3
100		37.1	14.0	8.6	6.3	4.9	4.1	3.5	3.3	2.7
150		55.6	20.9	12.9	9.4	7.4	6.1	5.2	4.9	4.0
200		74.2	27.9	17.3	12.5	9.8	8.1	6.9	6.5	5.4
250		92.3	34.9	21.6	15.6	12.3	10.1	8.6	8.2	6.7
300		111.2	41.9	25.9	18.8	14.7	12.2	10.4	9.8	8.0
350		129.8	48.9	30.2	21.9	17.2	14.2	12.1	11.4	9.4
400		148.3	55.8	34.5	25.0	19.7	16.2	13.8	13.0	10.7
50	2500	20.6	7.8	4.8	3.5	2.7	2.2	1.9	1.8	1.5
100		41.2	15.5	9.6	6.9	5.5	4.5	3.8	3.6	3.0
150		61.8	23.3	14.4	10.4	8.2	6.7	5.7	5.4	4.4
200		82.4	31.0	19.2	13.9	10.9	9.0	7.7	7.2	5.9
250		103.0	38.8	23.9	17.4	13.6	11.2	9.6	9.0	7.4
300		123.6	46.5	28.7	20.8	16.4	13.5	11.5	10.8	8.9
350		144.2	54.3	33.5	24.3	19.1	15.7	13.4	12.6	10.4
400		164.7	62.0	38.3	27.8	21.8	18.0	15.3	14.5	11.8

[1]Solution of gas and condensation under pressure are not considered; hence the values are maxima.
[2]Gas volumes entering into velocity calculations are based on tubinghead pressure; atmospheric pressure is assumed to be 15 lb. per sq. in. in calculating the number of atmospheres.



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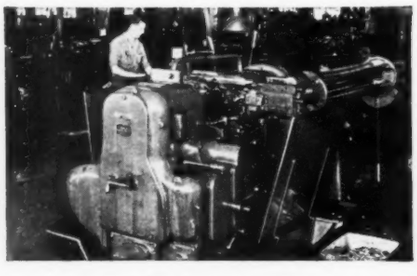


HYATT ROLLER BEARINGS

Carry the Load!

RISE IN FLUID LEVEL, ETC., DUE TO RUNNING 2½-IN. EXTERNAL-UPSET TUBING IN WELL FLUID

Diameter of outer string or open hole, in.	Internal diameter of outer string or open hole, in.	Volume[1] contained in outer string or open hole		Volume[1] contained in annular space		Volume[1] in well bore when tubing is in hole (volume in annulus plus volume in tubing)		For every 100 ft. of tubing run in fluid, fluid level will be raised:	
		gal.	bbl.	gal.	bbl.	gal.	bbl.	in annular space when lower end of tubing is closed, ft.-in.	in well bore when lower end of tubing is open, ft.-in.
Tubing strings									
Non-upset									
4	3.958	63.92	1.522	29.73	0.708	54.04	1.287	115- 0	18- 3
Upset									
4	3.958	63.92	1.522	29.73	0.708	54.04	1.287	115- 0	18- 3
Casing strings[2]									
4½	4.090	68.25	1.625	34.06	0.811	58.37	1.390	100- 5	16-10
4½	3.920	62.69	1.493	28.50	.679	52.81	1.257	120- 0	18- 8
5	4.560	84.84	2.020	50.65	1.206	74.96	1.785	67- 6	13- 2
5	4.276	74.60	1.776	40.41	0.962	64.72	1.541	84- 7	15- 2
5½	5.044	103.8	2.741	69.61	1.657	93.92	2.236	49- 1	10- 6
5½	4.670	88.98	2.119	54.79	1.305	79.10	1.883	62- 5	12- 5
6	5.524	124.5	2.964	90.31	2.150	114.6	2.729	37-10	8- 7
6	5.240	112.0	2.667	77.81	1.853	102.1	2.431	43-11	9- 8
6⅝	6.135	153.6	3.657	119.4	2.843	143.7	3.421	28- 8	6-10
6⅝	5.675	131.4	3.129	97.21	2.315	121.5	2.893	35- 2	8- 1
7	6.538	174.4	4.152	140.2	3.338	164.5	3.917	24- 5	6- 0
7	5.920	143.0	3.405	108.8	2.590	133.1	3.169	31- 5	7- 5
7⅝	7.125	207.1	4.931	172.9	4.117	197.2	4.695	19- 9	5- 0
7⅝	6.625	179.1	4.624	144.9	3.450	169.2	4.029	23- 7	5-10
8⅝	8.097	267.5	6.369	233.3	5.555	257.6	6.133	14- 8	3-10
8⅝	7.511	230.2	5.481	196.0	4.667	220.3	5.245	17- 5	4- 6
9⅝	9.063	335.1	7.979	300.9	7.164	325.2	7.743	11- 4	3- 0
9⅝	8.535	297.2	7.076	263.0	6.262	287.3	6.840	13- 0	3- 5
10¾	10.192	423.8	10.090	389.6	9.276	413.9	9.855	8- 9	2- 5
10¾	9.760	388.7	9.255	354.5	8.440	378.8	9.019	9- 8	2- 7
11¾	11.150	507.2	12.076	473.0	11.262	497.3	11.840	7- 3	2- 0
11¾	10.772	473.4	11.271	439.2	10.457	463.5	11.036	7- 9	2- 1
13⅜	12.715	659.6	15.705	625.4	14.890	649.7	15.469	5- 6	1- 6
13⅜	12.347	622.0	14.810	587.8	13.995	612.1	14.574	5-10	1- 7
Open hole (bit size)[3]									
3⅞	3.875	61.27	1.459	27.08	0.645	51.39	1.224	126- 3	19-10
4¼	4.250	73.70	1.755	39.51	0.941	63.82	1.520	86- 6	15- 5
4¾	4.750	92.06	2.192	57.87	1.378	82.18	1.957	59- 1	12- 0
5⅝	5.625	131.4	3.129	97.21	2.315	121.5	2.893	35- 2	8- 1
6	6.000	146.9	3.498	112.7	2.683	137.0	3.262	30- 4	7- 2
6⅛	6.125	153.1	3.645	118.9	2.831	143.2	3.410	28- 9	6-10
6½	6.500	172.4	4.105	138.2	3.290	162.5	3.869	24- 9	6- 1
6¾	6.750	185.9	4.426	151.7	3.612	176.0	4.190	22- 6	5- 7
7	7.000	199.9	4.760	165.7	3.945	190.0	4.524	20- 4	5- 2
7½[4]	7.500	229.5	5.464	195.3	4.650	219.6	5.229	17- 6	4- 6
7¾[4]	7.750	245.1	5.836	210.9	5.021	235.2	5.600	16- 3	4- 2
8½[4]	8.500	294.8	7.019	260.6	6.205	284.9	6.783	13- 1	3- 5
9¾[4]	9.750	387.9	9.236	353.7	8.421	378.0	9.000	9- 8	2- 7
10⅝	10.625	460.6	10.967	426.4	10.152	450.7	10.731	8- 0	2- 2

The 2½-in. external-upset tubing has a calculated weight of 6.44 lb. per ft. (including a coupling spaced every 20 ft.). The volume displaced by 100 ft. of tubing and 5 couplings: (1) by the steel itself (with end of tubing open), 9.841 gal. or 0.2343 bbl.; (2) by the pipe (with lower end of tubing closed), 34.19 gal. or 0.8140 bbl. The volume contained within 100 ft. of the tubing is 24.31 gal. or 0.5788 bbl.

[1]All volume figures are based on 100 ft. of depth; multiply to convert to other depths or lengths. For example, if the depth or length is 5196 ft., multiply by 51.96.

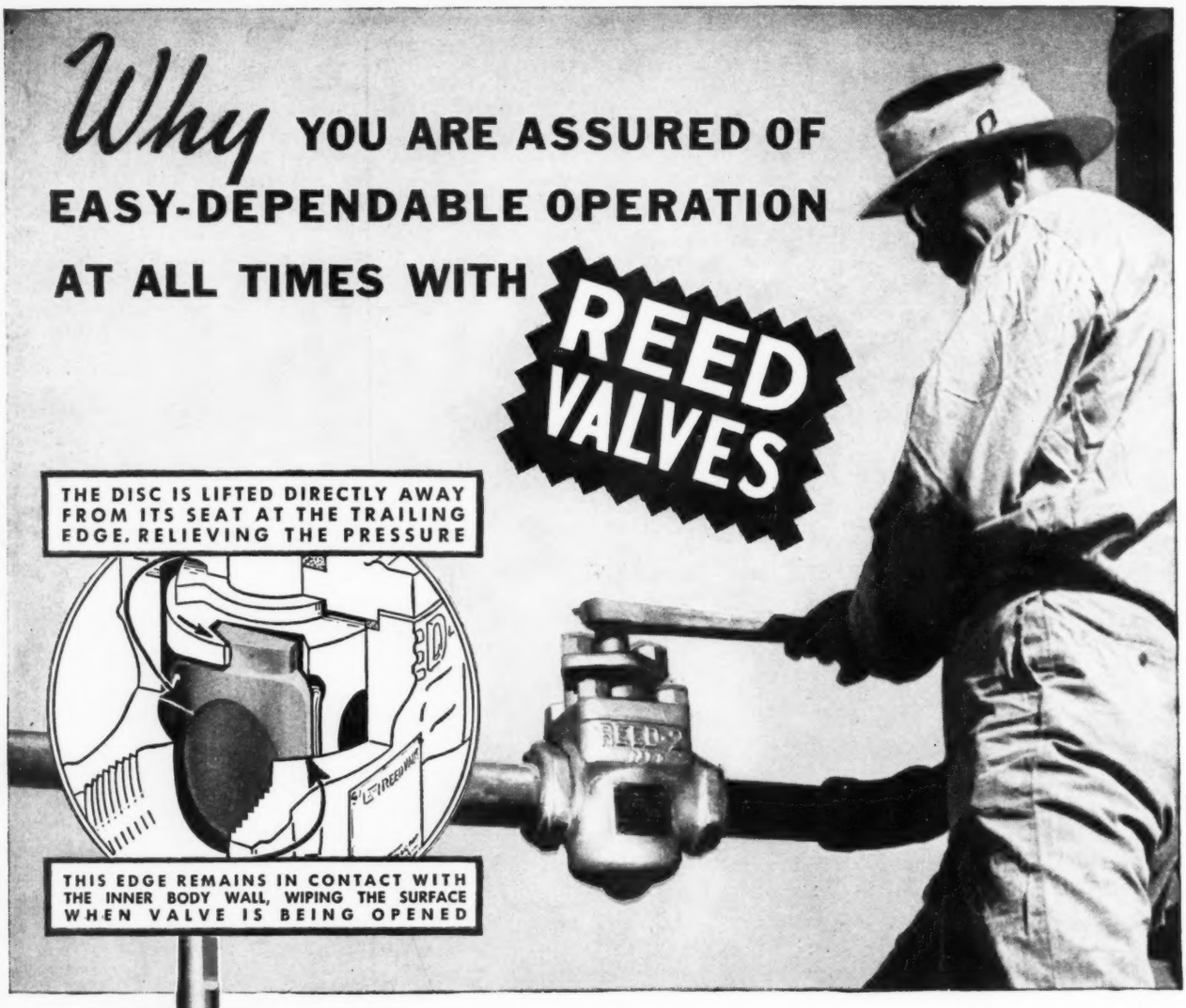
[2]Only maximum and minimum weights of pipe are shown for each casing size.

[3]Variation in diameter of open hole due to caving, etc., is disregarded.

[4]This diameter is an average of the two bit sizes ⅛ in. larger and smaller, respectively.

Table suggested by George B. Rice, Butler & Horne Drilling Co., Dallas, Texas.

Why YOU ARE ASSURED OF EASY-DEPENDABLE OPERATION AT ALL TIMES WITH REED VALVES


THE DISC IS LIFTED DIRECTLY AWAY FROM ITS SEAT AT THE TRAILING EDGE, RELIEVING THE PRESSURE
THIS EDGE REMAINS IN CONTACT WITH THE INNER BODY WALL, WIPING THE SURFACE WHEN VALVE IS BEING OPENED

The Reed Valve is opened or closed by a quarter turn of the Valve stem. A few degrees of rotation of the stem lifts the seating disc *directly away* from its seat *before* its starts to move to the open position.

This permits partial equalization of pressure on both sides of the downstream disc and further rotation of the stem carries the disc to the open position with ease.

In its open position, the Reed Valve provides a smooth flow of fluid guided by the conduit through the disc holder.

On your next valve problem, consult a Reed representative or write the Reed Valve Division.

[WRITE FOR THE NEW REED 41 VALVE DIVISION CATALOG TODAY]

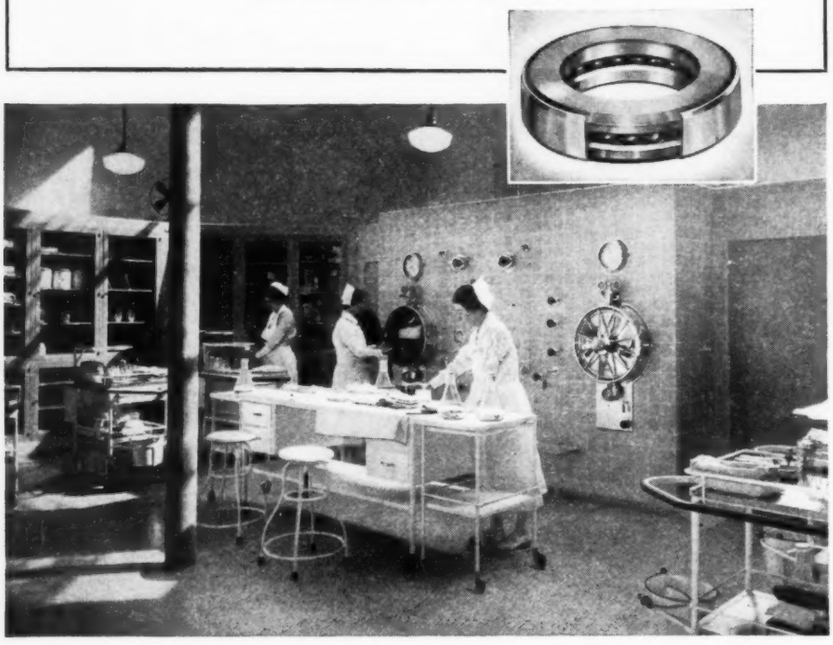
REED VALVE DIVISION
REED ROLLER BIT COMPANY
P. O. BOX 2119 HOUSTON, TEXAS

GRAVITY OF DRY OIL IN OIL-WATER MIXTURE, DEG. A.P.I.

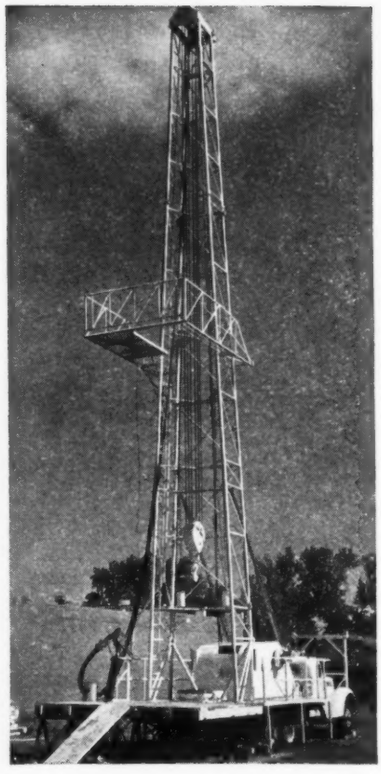
Gravity of "wet" oil, deg. A.P.I.	Percent water in mixture									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
35.0	35.04	35.07	35.10	35.13	35.16	35.19	35.22	35.25	35.28	35.31
.1	35.14	35.07	35.20	35.23	35.26	35.29	35.32	35.35	35.38	35.41
.2	35.24	35.17	35.30	35.33	35.36	35.39	35.42	35.45	35.48	35.51
.3	35.33	35.27	35.39	35.42	35.45	35.49	35.51	35.55	35.58	35.61
.4	35.43	35.36	35.49	35.52	35.55	35.58	35.61	35.65	35.68	35.71
35.5	35.33	35.46	35.59	35.62	35.65	35.68	35.71	35.74	35.78	35.81
.6	35.63	35.56	35.69	35.72	35.75	35.78	35.81	35.84	35.87	35.90
.7	35.73	35.66	35.79	35.82	35.85	35.88	35.91	35.94	35.97	36.00
.8	35.83	35.76	35.89	35.92	35.95	35.98	36.01	36.04	36.07	36.10
.9	35.93	35.86	35.99	36.02	36.05	36.08	36.11	36.14	36.17	36.21
36.0	36.03	35.96	36.09	36.12	36.15	36.18	36.21	36.24	36.27	36.31
.1	36.13	36.06	36.19	36.22	36.25	36.28	36.31	36.34	36.37	36.41
.2	36.22	36.16	36.29	36.32	36.35	36.38	36.41	36.44	36.48	36.51
.3	36.32	36.26	36.39	36.42	36.45	36.48	36.51	36.54	36.58	36.61
.4	36.42	36.36	36.49	36.52	36.55	36.58	36.61	36.64	36.68	36.71
36.5	36.52	36.46	36.59	36.62	36.65	36.68	36.71	36.75	36.78	36.81
.6	36.62	36.56	36.69	36.72	36.75	36.78	36.81	36.85	36.88	36.91
.7	36.72	36.66	36.79	36.82	36.85	36.88	36.91	36.95	36.98	37.01
.8	36.82	36.76	36.89	36.92	36.95	36.98	37.02	37.05	37.08	37.11
.9	36.92	36.86	36.99	37.02	37.05	37.08	37.12	37.15	37.18	37.22
37.0	37.02	36.96	37.09	37.12	37.15	37.19	37.22	37.25	37.28	37.32
.1	37.13	37.06	37.19	37.22	37.25	37.29	37.32	37.35	37.38	37.42
.2	37.23	37.16	37.29	37.32	37.36	37.39	37.42	37.45	37.49	37.52
.3	37.33	37.26	37.39	37.42	37.46	37.49	37.52	37.56	37.59	37.62
.4	37.43	37.36	37.49	37.52	37.56	37.59	37.62	37.66	37.69	37.72
37.5	37.53	37.46	37.59	37.63	37.66	37.69	37.73	37.76	37.79	37.83
.6	37.63	37.56	37.70	37.73	37.76	37.79	37.83	37.86	37.90	37.93
.7	37.73	37.66	37.80	37.83	37.86	37.89	37.93	37.96	38.00	38.03
.8	37.83	37.77	37.90	37.93	37.96	38.00	38.03	38.07	38.10	38.13
.9	37.93	37.87	38.00	38.03	38.07	38.10	38.14	38.17	38.20	38.24
38.0	38.04	38.07	38.10	38.14	38.17	38.20	38.24	38.27	38.31	38.34
.1	38.14	38.17	38.21	38.24	38.27	38.31	38.34	38.37	38.41	38.44
.2	38.24	38.27	38.31	38.34	38.37	38.41	38.44	38.38	38.51	38.55
.3	38.34	38.37	38.41	38.44	38.48	38.51	38.55	38.58	38.61	38.65
.4	38.44	38.47	38.51	38.54	38.58	38.61	38.65	38.68	38.72	38.75
38.5	38.52	38.56	38.59	38.63	36.68	38.71	38.73	38.78	38.80	38.83
.6	38.62	38.66	38.70	38.74	38.78	38.81	38.83	38.87	38.90	38.94
.7	38.71	38.76	38.80	38.83	38.87	38.91	38.94	38.97	39.01	39.04
.8	38.83	38.86	38.90	38.94	38.97	39.01	39.04	39.08	39.11	39.15
.9	38.93	38.96	39.00	39.04	39.07	39.11	39.14	39.18	39.21	39.25
39.0	39.04	39.07	39.11	39.14	39.18	39.21	39.24	39.28	39.31	39.36
.1	39.14	39.17	39.21	39.25	39.28	39.32	39.35	39.39	39.42	39.46
.2	39.24	39.28	39.30	39.35	39.38	39.42	39.46	39.48	39.53	39.56
.3	39.33	39.36	39.40	39.43	39.47	39.50	39.54	39.58	39.61	39.65
.4	39.43	39.46	39.50	39.54	39.57	39.62	39.64	39.68	39.72	39.75
39.5	39.53	39.57	39.60	39.64	39.68	39.72	39.75	39.78	39.82	39.86
.6	39.64	39.67	39.71	39.74	39.78	39.82	39.85	39.89	39.93	39.96
.7	39.74	39.78	39.81	39.85	39.88	39.92	39.96	39.99	40.03	40.07
.8	30.84	39.88	39.91	39.95	39.99	40.03	40.06	40.10	40.13	40.17
.9	39.94	39.98	40.00	40.04	40.07	40.11	40.15	40.18	40.22	40.26

Gravity of dry oil in oil-water mixture, degrees A.P.I. with percent water in mixture less than one suggested by R. W. Miller, Phillips Petroleum Company, Oklahoma City, Oklahoma.

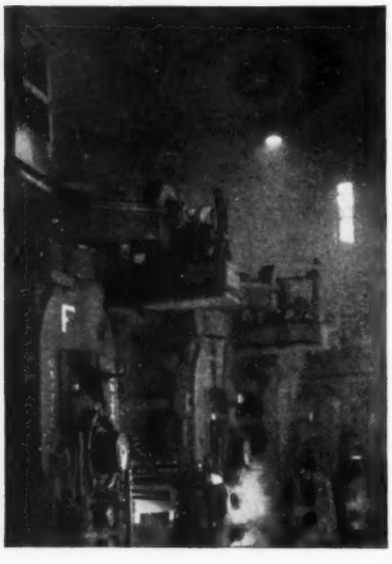
IN THE NEWS
WITH BANTAM BEARINGS



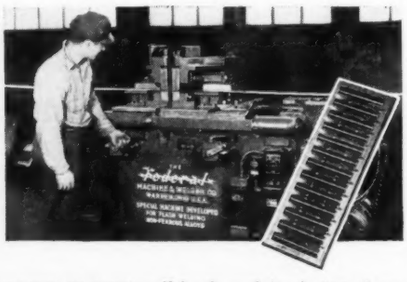
SAFETY IN SURGERY took a long stride forward when American Sterilizer Company originated the temperature-control technique for effective sterilization of instruments and supplies. These precision instruments, shown above in the Hospital of the University of Pennsylvania, embody the most modern principles in engineering design. A feature is the use of Bantam Ball Thrust Bearings in the door-locking mechanism to facilitate easy operation.



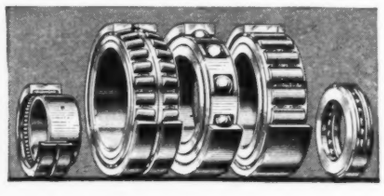
THE QUEST FOR OIL BECOMES SIMPLER as progressive manufacturers develop new equipment designed for economical prospecting. Outstanding example is George E. Failing Supply Company's new "66" portable slim hole drilling rig, equipped with Bantam Quill Bearings in crown and traveling blocks, to give efficient operation.



GIANT BEARINGS in single, double and four-row types up to 51" O.D., designed and built by Bantam for the steel industry, have made outstanding performance records. Both work rolls and back-up rolls of the continuous hot strip mill shown above are Bantam equipped for long life and successful performance in severe service.



MASSES OF METAL roll back and forth 200 times an hour in this high-speed production welding unit built by The Federal Machine and Welder Company—roll smoothly and efficiently on special ladder-type bearings designed by Bantam. Bearings of this type find many applications where friction in reciprocating motion must be kept to a minimum.



EVERY MAJOR TYPE of anti-friction bearing is included in Bantam's line—straight roller, tapered roller, needle, and ball. Bantam serves every industry with a wide range of standard bearings that meet many normal requirements. Bantam engineers offer unbiased advice on selection of standard bearings—and design custom-built bearings in large sizes or special types for unusual conditions. If you have an exceptionally difficult bearing problem, TURN TO BANTAM.

BANTAM BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

BANTAM BEARINGS CORPORATION • SOUTH BEND • INDIANA

Fig. 1. Introducing paraffin solvent through the tubinghead of an East Texas well

PETROLEUM Exclusive

by
Guy F. Williams
Dowell Incorporated

Essential Factors in Planning Paraffin Solvent Treatments

☆ Type of treatment should fit the specific well conditions—Examples are given of results obtained in various fields

CHEMICAL paraffin solvents are now being used successfully in many instances to restore oil production by removing plugging materials obstructing the flow of oil in the critical zone.

Recently at Leeville in LaFourche Parish, Southern Louisiana, it was observed that debris taken from the mud anchors of pumping wells contained carbonate scale particles cemented together by paraffin. These wells responded to a slight degree by washing out with salt water. Further, it was found that they could be filled with oil or water, a condition not normal in old partly depleted pumping wells. As time passed, the wells made less and less fluid, although wells of this area were usually prone to increase in salt water production as daily oil output decreased.

With the foregoing facts in mind, the theory was developed that the proper paraffin solvent spotted on the face of the pay would dissolve at least one part of the plugging agent on or near the sand face. Any oil increase here would prove that progress was being made in solving the problem economically.

GUY F. WILLIAMS

was graduated from high school at Newton, Kansas, in 1926—Received A.B. degree from Lake Forest University, Illinois, in 1930—Worked for the Williams Drilling Company during college vacations—Employed by the Bridgeport Machine Company from 1935 to 1936—Became associated with Dowell Incorporated September 18, 1936.

A pumping well was first selected because the carbonate scale had been removed already by a commercial scale-removing chemical treatment, resulting in a production increase of from 5 to 70 bbl. per day. This scale was known to contain paraffin as an additional plugging material.

In making the paraffin removal treatment, 50 gal. of commercial paraffin solvent was pumped into the casing using a low-pressure pump followed in this particular case with the casing volume of water. The water was lighter than the solvent, but heavier than the oil. The tubing with rods in place remained open during the treatment, but the tubing and casing were both closed-in overnight after the application of the solvent. The well was put on the pump the following morning and averaged 100 bbl. daily for the next 30 days, which was an increase of 30 bbl. per day attributable to the solvent treatment. The total increase in production in the 30-day period was 900 bbl. The approximate cost of the entire treatment was $75 for solvent plus $25 for labor.

As this treatment indicated that there was a plugging agent obstructing the oil flow and that the above-described treating procedure produced favorable results, a second well was treated. The second well selected was

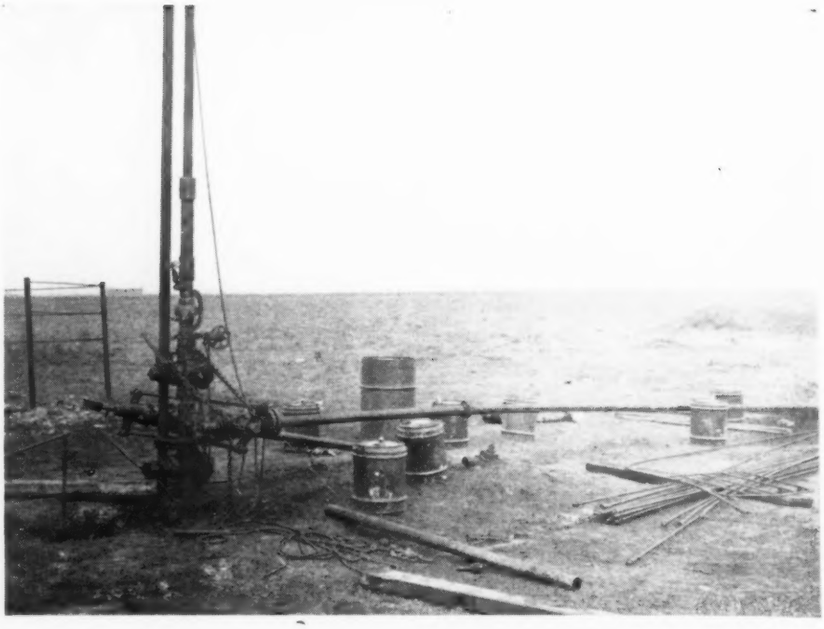


Fig. 2. Showing a well during a paraffin solvent treatment

a flowing well with an initial production of 1500 bbl. daily. During the work-over, considerable rotary drilling mud had been lost in the sand, and production was only 120 bbl. per day at the time the solvent treatment was made. The solvent treatment was proposed because it was in close proximity to the original pumping well treated with the paraffin solvent and also because the scale in this well contained carbonate material and paraffin.

The method used was virtually identical with that followed in the pumping well treatment with the exception that the well was allowed to flow on ¼-in. choke through the tubing while the paraffin solvent and the fluid load were being injected into the casing. This well made 300 bbl. per day immediately after the paraffin solvent treatment and 30 days later it was making 263 bbl. a day, an increase of 143 bbl. a day attributable to the paraffin solvent treatment.

Four wells have been treated to date with paraffin solvent in this pool and all increases have been large. In one instance the production of a 150-bbl. well was increased to 300 bbl. per day, sustaining this rate for several months. Standard treating practice in this pool on these old low-pressure, low-temperature wells producing through screens is to introduce 50 gal. of solvent down the casing and follow with the casing volume of either oil or water although oil is recommended. The tubing is left open while the fluid is being introduced, and after treatment, it is closed-in. The well is permitted to set closed-in overnight, and next morning approximately 30 bbl. of the oil or water is squeezed into the formation. The volume of the normal fill-up overnight is generally the quantity squeezed into the formation.

The wells discussed are producing through screens; it is not definitely known, therefore, whether the increases in production were due to the cleaning of the screens, or to the removal of the paraffin from the formation, or both. In order to clarify this point, other such treatments were conducted in areas where it is not a practice to set screens.

In Illinois two wells were selected that were producing in the McClosky lime. Their initial production and recovery were high but production had gradually declined. During a production test from September 15 to October 15, 1940, a total production of only 558 bbl. of oil was obtained from both wells. One well was given a paraffin solvent treatment on October 16 and the other was treated October 23. Total production of the two wells from October 16 to November 14 was 1130 bbl. and several weeks later the production from the two wells was still about 40 bbl. per day.

Identical methods were used in treating these two pumping wells. Fifty gallons of the commercial solvent was mixed with 50 gal. of gasoline at the wellhead, and the mixture was introduced through the casing at the casinghead followed by 18 to 20 bbl. of flush oil. The tubing and casing were connected and the mixture was circulated for 12 hr. by pumping the well. The well was then placed on production.

The cost of treatment for both wells was as follows:

100 gal. paraffin solvent @ $1.50 per gal.	$150
100 gal. gasoline @ $0.15 per gal.	15
36 bbl. oil (oil recovered)	n.c.
Total cost	$165

Results:

1130	bbl. oil recovered in 30-day period (Oct. 16 to Nov. 14, 1940) following treatment.
558	bbl. oil recovered 30-day period preceding treatment.
572	bbl. net recovery due to treatments.

The wells continued to produce at the rate of approximately 40 bbl. per day average, and in the 30-day period from November 15 to December 14, 1940, 1488 bbl. of oil was recovered.

In December, considerable paraffin began to appear in the oil produced by these wells and they were again treated with the same amount of paraffin solvent on December 15 and December 17, respectively. A production test following treatment showed the two wells to be making 70 bbl. per day, which is an even greater rate of production than was obtained following the first treatment.

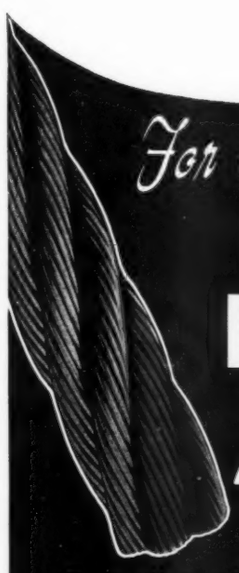
These production increases are not phenomenal, but are the result of careful study by the operator and of employment of the proper paraffin solvent with the correct method of application.

Generally speaking, in making treatments such as those described above, the following points should be remembered:

1. In order for a treatment to be successful, the well's flow must be impeded by paraffin.
2. The paraffin must be soluble in the particular solvent used.
3. In making a treatment a considerable quantity of oil must be used in flushing the solvent down. For this purpose operators have been using oil from the identical well being treated.
4. When the circulation method of treatment is used, a sufficient circulating time, generally 12 to 24 hr., should be allowed.

In selecting wells for paraffin solvent treatments in Illinois, it has been found that the best results are upon small producers. When larger wells are treated, it is necessary to use larger amounts of solvent as the smaller amount of solvent apparently becomes too thinly distributed to give satisfactory results, particularly upon relatively insoluble types of paraffin.

Wells producing from two sands at the same time have not responded to



For **rotary drilling**

HAZARD LAY·SET *Preformed*

Regardless of where you are—or what your drilling job may be—there is a Hazard Wire Line to fit your need. On rotary rigs, if you want more footage per line, Hazard LAY-SET Preformed Green Strand will give it. That's the line that is easy to string; stands the "gaff" of the heavy shock loads; resists whipping; makes possible faster round trips; spools better.

You see, the preforming process through which Hazard LAY-SET passes at the mill completely relieves the steel of all internal stresses and strains. It makes Hazard LAY-SET a pre-broken-in line—one that you don't have to "baby" when first installed. More than this, the preforming process endows LAY-SET with amazing fatigue resistance—with longer life as the result. Hazard LAY-SET Preformed is such a superior line that more than nine out of ten drillers who use it for the first time automatically come back for their second, third and successive lines.

For **cable tool drilling**

HAZARD "NONPARELL" *Non-preformed*

With cable tools it's a matter of getting more hole per foot of line—and that's where Hazard "NONPARELL" does its stuff. Backed by 95 years of wire rope making experience, Hazard "NONPARELL" has the reach—withstands the wear in open hole—and drills off nicely.

On any other job—bailing, swabbing, cleaning out—there is a Hazard Wire Line of the correct size and construction to meet your demand for wire line satisfaction and economy. There is a Hazard district office or distributor near you. More than this, Hazard representatives are oil field engineers. They know your problems; they know drilling lines. Let them help you get more and better rope service. Hazard District Offices and Hazard Distributors pride themselves on their immediate delivery service. You can always depend on Hazard. All Hazard Wire Lines Identified by the Green Strand are Made of Improved Plow Steel.

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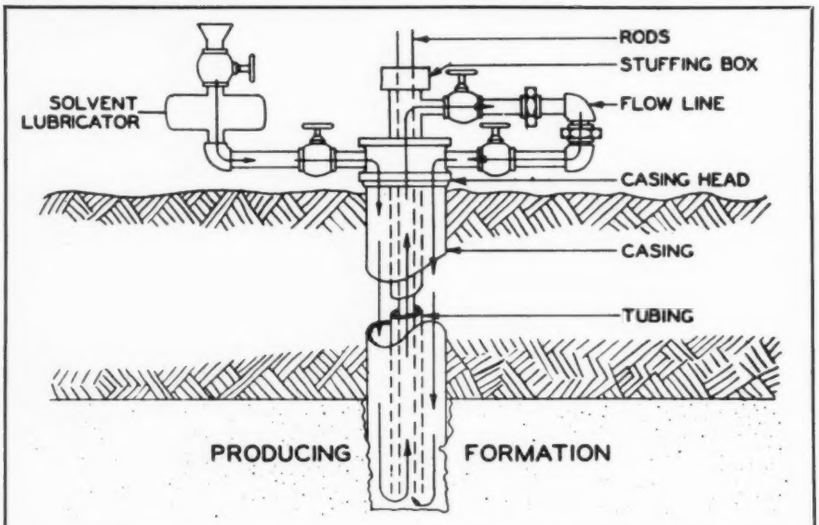


Fig. 3. Sketch of typical wellhead hookup for introducing paraffin solvent

paraffin solvent treatments as successfully as those producing from only one sand body. A recent treatment upon a well producing from two sand pay sections, the upper of which was producing through gun perforations in the pipe, was not a commercial success. Previously, a well in the same territory producing only from the upper sand had given very good results after treatment. In the well that did not satisfactorily respond it is probable that the solvent passed over the perforated area in the pipe and did not enter the perforations to clean the paraffin from the sand face.

Paraffin solvent is not a cure-all, and if the proper procedure is not followed, satisfactory production increases cannot be expected. There should be good reason to believe that production in the well selected for treatment is declining because of paraffin. A sample of the paraffin from that particular well should be tested in various commercial solvents, and the one that gives the most complete removal should be used. The proper mechanical application method must be followed, and the solvent must be brought into contact with the paraffin deposit if it is expected to give good production increases.

P 425.217

Preformed Rope Saves Time When Threading Drums

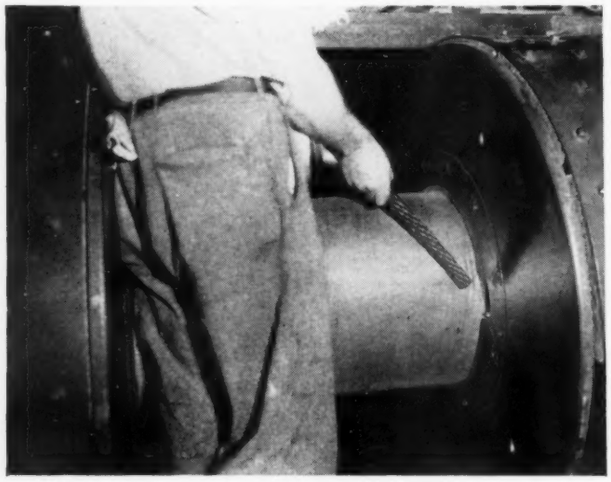


Fig. 1. Preformed rope requires no seizings; the end retains its shape so the rope is easily and quickly passed through the eye of the drum

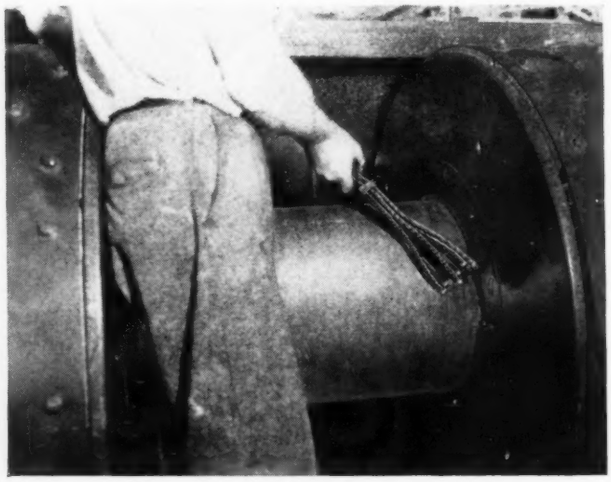


Fig. 2. The end of a non-preformed rope frays out, making it difficult to pass the end through the drum eye. In addition, the rope must have seizing applied to hold the strands in position, and each individual strand must have a seizing at its end to hold the wires in position

EVER try to thread a needle with a fuzzy-ended thread?

It's about as exasperating and wasteful of time as trying to put the frayed end of a rope through the eye of a drum.

When threading a drum, a rope that does not fray has an advantage over one that does. The illustrations show what happens when threading with preformed rope and with non-preformed rope. The wires and strands of the preformed rope stay in place and remain snug against one another. With the non-preformed rope, each strand must be seized by tape or wire at its end, and even then the strands themselves spread out, so the reever has a real problem on his hands of how to get the rope end through the drum eye. In addition, a wire seizing must be applied near the end of the non-preformed rope so that the unlaying of the strands at the end of the rope will cause no change or displacement of the strands in the rope beyond the seizing.

Threading with preformed rope is easy and saves time because: (1) no seizing is required at the ends of the individual strands; (2) the rope itself does not have to have a seizing applied, and (3) the end of the rope, remaining compact without change in shape, is easily passed through any hole large enough to receive the rope itself.

Oil FOR NATIONAL DEFENSE

FROM the days of the Drake well to the present, the American Oil Industry has met every obstacle and will, in this emergency, continue to do its job and fulfill its responsibility to its country.

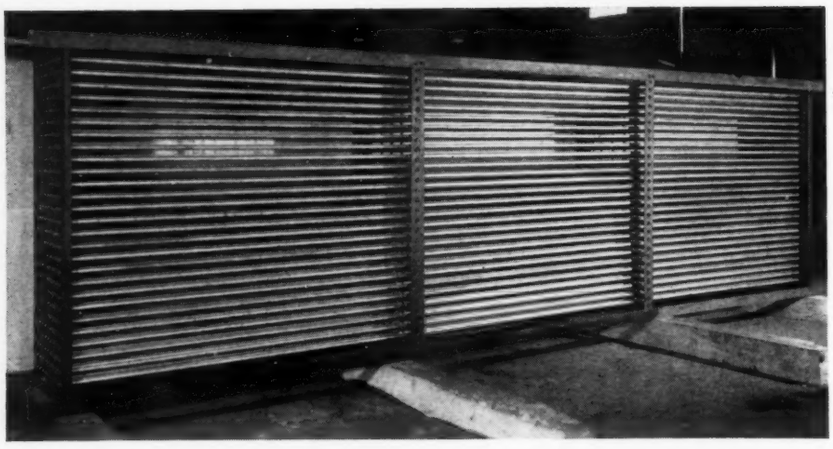
However, the petroleum industry has not worked alone in its accomplishments. **American manufacturers** have met, and in many cases anticipated its every need; have evolved, designed and produced the tools, methods and equipment used in every branch of the great oil industry.

In order to provide the meeting place of these two groups, **The International Petroleum Exposition** will hold its **Twelfth Oil Show** in **Tulsa, May 16th to 23rd, 1942,** where scientists, engineers, and technicians of the manufacturing and petroleum industries may compare, discuss, plan, and test the equipment which will insure **Oil for National Defense.**

For further information write: Wm. B. Way, General Manager International Petroleum Exposition, Tulsa, Oklahoma, U.S.A.

INTERNATIONAL PETROLEUM EXPOSITION

TULSA, May 16-23, 1942



Assembled cooler without the heads

PETROLEUM ENGINEER EXCLUSIVE Feature

Submerged Coolers For Refinery Service

☆ **Multiplicity of tubes of varying lengths, with heads bolted to tube sheets at each end of cooler, adopted in modern design**

by David E. Fields

Vice-President and Sales Manager, Tulsa Boiler and Machinery Company

SUBMERGED coolers are used at oil refineries for condensing and cooling the streams of the various products manufactured. At the older refineries the coolers were usually made of long bends of pipe submerged in a condenser box. In modernizing these older plants the pipe coils are usually replaced with the submerged cooler having a multiplicity of tubes of varying lengths and the heads bolted to tube sheets at each end of the cooler. On many of the new refinery installations the submerged coolers are installed.

The heads and tube sheets of the coolers are usually of cast iron; however, cast-steel heads with steel plate tube sheets are used on cooling gas, oil, or distillate streams when the inlet temperature is rather high.

The inlet nozzles are at the top of the sections and the outlet nozzles at the bottom so that counter-flow will be obtained in the vapor and/or liquid as it passes through the cooler. The colder water is at the bottom of the condenser box with the warmer water at the top of the box at the overflow.

The tubes used may be plain admiralty or admiralty with various alloys or seamless steel tubes.

The framework on the submerged cooler is made of steel, sometimes galvanized, but usually painted with an asphalt base paint to withstand the corrosive action of the cooling water.

DAVID E. FIELDS

received a B.S. degree in mechanical engineering from University of Oklahoma in 1925—Joined the Tulsa Boiler and Machinery Company, Tulsa, Oklahoma, the same year and left in 1926 to join the Shell Petroleum Corporation organization in the construction division—Returned to staff of Tulsa Boiler and Machinery Company and now is vice-president and sales manager and has charge of the engineering and design of gasoline plant and refinery equipment—Is a member of the Tulsa Club, Tulsa Engineer's Club, Technical Club of Oklahoma, Oklahoma Society of Professional Engineers, Masons, and is a past president of the Natural Gasoline Supply Men's Association.

Number and Size of Cooling Sections

The duty on the particular cooler determines the number and size of the submerged cooling sections. The size is also influenced by the depth and width of the condenser box. In the case of replacing existing pipe coils the submerged coolers are designed with the tubes as long as possible. They are made to fit in the existing condenser boxes and leave room at the ends for the heads and for some clearance at the ends of the heads, that is, between the ends of the condenser box and the heads. This method of determining the length of the cooler gives the purchaser the most for his money on a square-foot basis.

In the vapor condensers and coolers the cross-sectional area of the passes are reduced as the vapors pass on through the submerged condensers and are reduced in volume due to condensation of the liquid. This results in a more uniform velocity through the section and also gives a higher overall coefficient of heat transfer for a given pressure drop through the condenser. The vapor condensers are usually hooked-up in parallel and the coolers in series if more than one section is required. In liquid coolers the cross-sectional area of the passes are usually the same throughout the cooler.

Replacement

During the life of submerged coolers in oil refinery service it is usually necessary to replace the tubes because of corrosion on the vapor and liquid side or on the cooling-water side of the tubes. If no provision is made to do this from the sides of the coolers

This Tower of Strength . . .

keeps dollars in your pocket

THE dollars you keep in your pocket rather than spend for replacements and repairs are the true measure of the over-all economy of a pumping unit installation. To keep running efficiently with minimum upkeep, a pumping unit must first of all be constructed around a frame that is stable and rigid. ***"Oilwell"*** assures these characteristics by providing a DERRICK-TYPE samson post with four strong legs firmly mounted on a sturdy base of big steel beams.

The front legs are extended toward the well, and at no time does the direction of the resulting load on the saddle bearings exceed the slope of these legs. This means that the unit is entirely self-supporting, with no tendency to weave or nose over.

The "Oilwell" frame construction:

- ★ **provides a rigid and stable self-supporting assembly.**
- ★ **maintains the original accurate alignment of the bearings.**
- ★ **minimizes and equalizes stresses.**
- ★ **prolongs the useful life of parts.**

. . . thus, keeps your dollars in your pockets.

"Oilwell" pumping units have many other money-saving features, and are available in economical sizes and types for all applications. Ask for specifications.

THE STABLE AND RIGID FRAME CONSTRUCTION, *including the four-leg DERRICK-TYPE samson post, is standard* **for all sizes of** *"Oilwell"* **pumping units.** *In the smaller sizes it provides the added advantage of permitting economical twin-well pumping by means of an inexpensive V-attachment on the underside of the beam working through the samson post.*

OIL WELL SUPPLY COMPANY

it is necessary to lift the submerged sections out of the condenser box in order to have free space in front of either the front or rear tube sheets great enough to pull out and replace tubes. One novel method of replacing tubes from the sides of a cooler while it remains in place in the condenser box has been on the market for about three years and is giving highly satisfactory results. This type of cooler is patented. Submerged coolers of this type are now in service in Oklahoma, Texas, Louisiana, Kansas, Illinois, Indiana, and the state of Washington.

The framework of the cooler is made of four heavy angles placed at the four corners of the heads and tube sheets and extending from one head to the other. At several points along these angles vertical angles are bolted opposite each other and these have a series of holes in which are placed rollers so that each roller supports a row of tubes in the submerged cooler. As the tubes in the coolers expand and contract, the rollers rotate slightly thus eliminating the wear at these points on the tubes. Vertical "U" tube spacers are placed over every other vertical row of tubes in the submerged cooler, which keeps the tubes in place.

Above—Illustrating the ease with which new tubes are inserted

Right—Angles folded down and "U" tube spacers removed

The vertical "U" tube spacers and the rollers are locked in place.

To replace any tube or all tubes in the submerged cooler the heads are unbolted from the tube sheets and the tube or tubes drilled out of the tube sheets. The necessary "U" tube spacers are removed vertically from the top of the cooler and then the rollers are unlocked from the vertical angles and pushed out from the holes in the vertical angles on one side of the cooler. Three of the four bolts in each vertical angle are removed and the vertical angles folded down. Then any tubes may be removed from the cooler by pushing each tube through one tube sheet hole a few inches; by springing the tube slightly it is easily removed. The above operations are reversed in replacing tubes. The new tubes are then rolled in the tube sheets and the heads bolted back on. The cooler can then be tested and placed back in operation. Not more than 2 ft. of space is required along the sides of the coolers for this work.

Close-up of tube supports

No longitudinal welds
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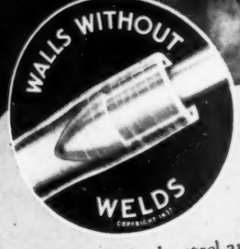

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NATIONAL TUBE COMPANY

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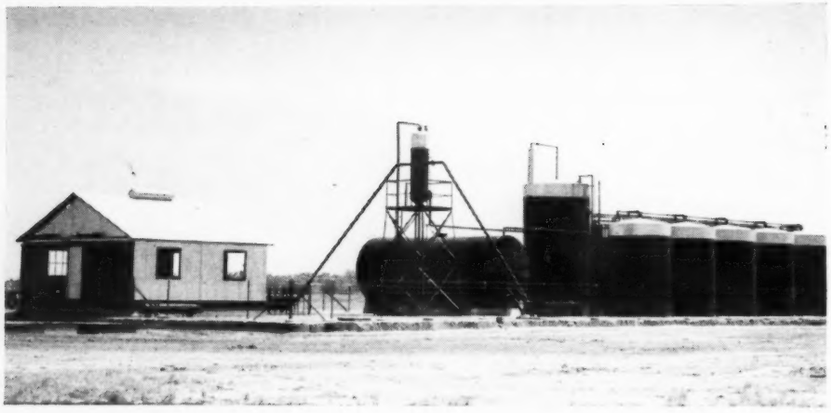

Fig. 1. General view of central plant and lease tanks

PETROLEUM ENGINEER Exclusive Feature

by H. Lee Flood
Associate Editor

☆ Horizontal settling tank employed in system installed on 20-well lease in Hull-Silk field

Design and Installation of Hydraulic Well-Pumping System

IT is needless to point out to contemporary production engineers that the problem of selecting the lifting equipment for a group of producing wells is one that properly should be given a great deal of thought and study. There are so many different methods available today—all for the purpose of lifting crude oil to the earth's surface—that it is only by a careful consideration of the advantages and disadvantages of each method correlated with the specific requirements, characteristics, and limitations of the well or group of wells to be served by the equipment that a reasonably accurate selection may be made.

Having so many methods and combinations of methods from which to choose, it might seem that the production engineer should be able to specify a production program that would fulfill the specific requirements exactly. Unfortunately, however, there are few instances in actual practice when one definite lifting method may be selected without at least a preliminary study in which two or more methods are considered. Often the presence or absence of one factor may eliminate some method from consideration, such as an insufficient supply of gas to permit gas-lift operation. Other factors may militate against or favor a lifting method but it is seldom safe to decide too quickly for or against a specific method without setting up a fairly thorough, unbiased study.

It would appear at first glance that the only definite figures an engineer may rely upon safely are the respective first costs of the lifting methods being considered. These respective costs do constitute an important basis for comparison but no longer do they necessarily represent the only consideration leading to purchase of equipment. Many factors, tangible and intangible, are now given full weight in evaluating the relative overall costs of equipment. It is in estimating the operation and maintenance costs, life of the equipment, future trends of the producing wells, and the many other items that must be evaluated that experience plays an important part. Experience and the ability to recognize minor factors and assign reasonable weight to each item are essentials for which there can be no substitutes.

Obviously, there can never be two leases, even two wells, that are identical in all characteristics and for this reason no one lifting method can be expected to be entirely universal in application. Otherwise there would not be so many diverse types in existence, each of which may be quite successful and efficient when employed properly.

Without further discussion of the broad considerations underlying comparative studies of lifting equipment, the present article will describe the design and installation of one type of lifting equipment — the hydraulic pumping system—on a 20-well lease owned by Continental Oil Company in the Hull-Silk area, near Wichita Falls, Texas. It is not essential to dwell on the factors that led to the selection of this method other than to state the more or less obvious fact that this method appeared to offer the most economical service from the overall standpoint under the specific condi-

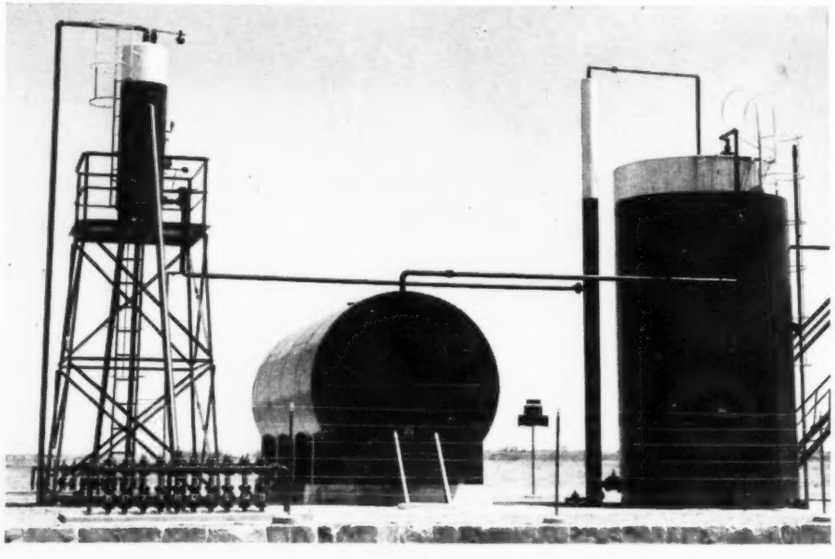

Fig. 2. Vessel in center is 10-ft. by 24-ft. settling tank; 10-ft. by 20-ft. gun barrel on right. Valves on lead lines from wells are shown at base of oil-gas separator

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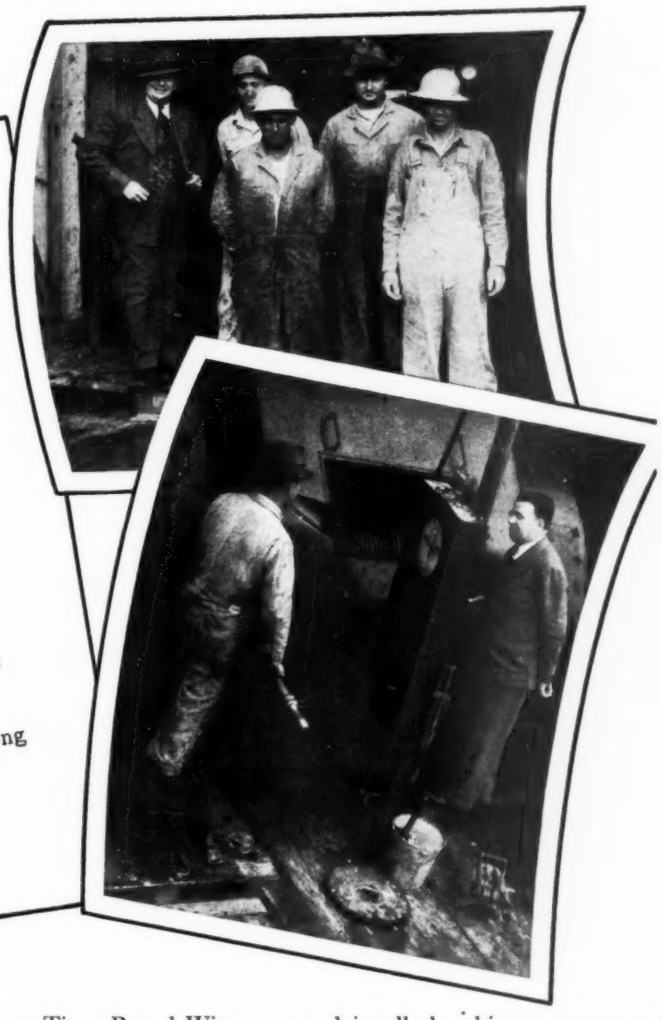

Here are two more pictures you can put in your photo file, Boss. Every man in this crew is a real booster of Tiger Brand Wire Lines. They're all old hands in this drilling business, and have seen plenty of wire lines in action. And from the driller down they say they'll rely on Tiger Brand every time --for longer service, and lower operating costs.

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Ray

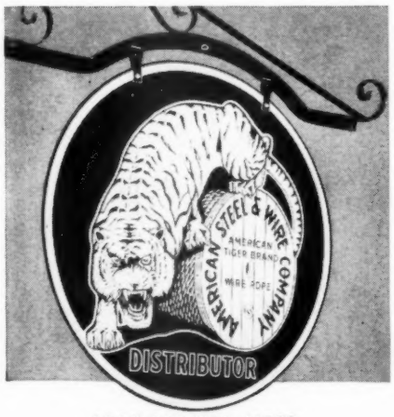

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Fig. 3. Symmetrical manifold arrangement provides centralized control of all 20 wells

tions present. If the conditions had been materially different, as they well might be in the next lease studied, the choice might have been some entirely different method.

Characteristics of Wells

As stated, the lease consists of 20 wells, the total depth of which will average 4350 ft. The daily allowable for the lease currently is approximately 750 bbl. or 37½ bbl. per well. All wells were equipped with 2-in. tubing for flowing purposes prior to the installation of pumps.

The average gas-oil ratio on the lease was approximately 350 cu. ft. per bbl. of oil. The oil delivered to the pipe line (without treatment) averaged 0.2 to 0.4 percent B. S. and water.

The spacing of the wells and their relative positions were such as to suggest some method of central operation and it was this, together with other considerations, that led to a study of hydraulic pumping employing a central plant for pumping power oil to the individual well units.

Factors to Consider in Design

In addition to describing the details of this specific installation, it may be of interest to production engineers to outline the essential factors to be considered in broad enough terms so that at least a preliminary study can be made of the application of hydraulic pumping to other wells on other leases.

Table 1 has been prepared to indicate (1) the factors that must be considered in designing a hydraulic pumping system; (2) which of these factors enter into the design of the various component parts of the pumping system, and (3) the values determined for the specific 20-well lease under consideration.

It should be pointed out that Table 1 lists all factors that should at least be considered but, as in the present instance, many of these data may not be available and can be either disregarded or estimated with reasonable accuracy. Usually it is advisable to disregard actual existing conditions and assume the most adverse conditions that might develop in order to have an adequate capacity factor. For example, in the present design, the existing water-oil ratio and productivity index were disregarded by assuming the wells might eventually produce 100 percent water of 1.1 specific gravity at zero (gauge) bottom-hole pressure.

Design of Component Parts

Essentially, a hydraulic pumping system consists of two major parts: (1) the surface, or hydraulic power unit supplying clean power oil to (2) the subsurface, or production unit. The power unit pumps clean crude oil down the well under sufficient pressure to operate the production unit, which consists of a hydraulic reciprocating engine direct connected to a reciprocating pump. The production unit is usually run as an insert pump, seating in a shoe in the well tubing in the conventional manner. The tubing on which the pump is run serves to conduct the power oil from the surface to the subsurface unit, and is termed the power oil tubing. The discharged power fluid mixes with the crude oil produced from the formation and is returned to the surface in the annular space between the power oil and well tubing strings.

Based on the present allowable per well and estimating additional capacity

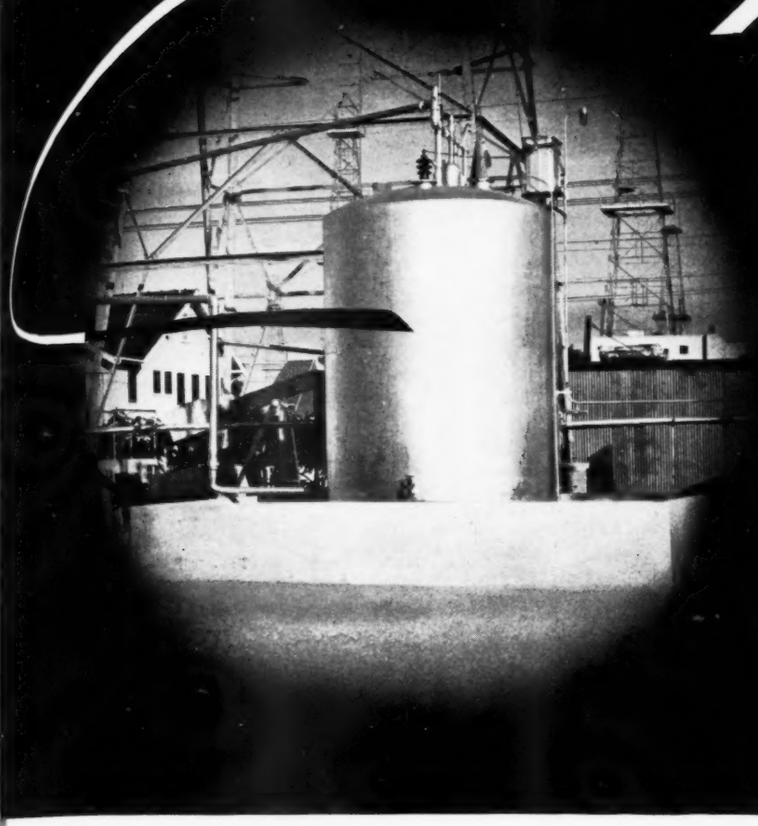
Fig. 4. Operator may readily determine from pressure gauge (1) the speed of the subsurface unit, (2) whether well has "pumped off", and (3) the fluid level in the well. Thus, all wells may be completely controlled without leaving the central plant site

TABLE 1

Factors governing design of hydraulic pumping system

Factors to be considered		Values assigned for 20-well system		Component parts of hydraulic pumping system		Values assigned for 20-well system	Factors on which selection of item is based (see symbols in left hand column)
Symbol	Description	Symbol	Value				
1	No. wells on lease	1	20				
2	Daily rate of total fluid desired per well for normal production	2	40 bbl. per day	Subsurface pump	Number	20	1
					Size	2 in.	2, 3, 4, 7, 8, 9, 10, 11, 14, 15 (see Table 5)
3	Daily rate of total fluid for potential purposes	3	none considered		Type (csg. or insert)	insert	2, 7, 8, 9, 10, 11, 12, 13, 14, 15
4	Percent water in total fluid	4	Consider fluid 100 percent water of 1.1 sp. gr.	Production tubing	Amount	4300 ft.	9, 14
5	Gravity of oil	5			Size	2 in.	7, 8, 15, and size of subsurface pump
6	Gravity of water	6			Type	external upset	9, 14
7	Size and setting of casing	7	7 in., 4300 ft.				
8	Size and setting of liner	8	none installed	Power oil tubing	Amount	4300	14
9	Total depth of wells (avg.)	9	4350 ft.		Size	¾ in.	size of subsurface pump (see Table 3)
10	Static bottom-hole pressure	10	Not known		Type	external upset	14
11	Productivity index	11	Consider fluid level at bottom of well	Power oil surface lines	Amount	1910 ft.	16, 17, 18
12	Solution gas curve	12	Not available		Size	1 in.	2, 3, and size of subsurface pump
13	Gas not in solution (under bottom-hole pressure conditions)	13	Not available		Type	grade B" line pipe	10, 11, and size of subsurface pump
14	Desired pump setting	14	4300 ft.	Central plant units	Number	2	(see Table 4 and horsepower formula)
15	Size of tubing in well at present (if any)	15	2-in. external upset		Size	3-cylinder triplex	2, 3, 4, 6, 10, 11, 15, and size of subsurface pump
16	Well spacing	16	20 acres		Type	gas engine drive	19
17	Topography of lease	17	level				
18	Location of tank battery or settling system	18	approximately in center of lease	Power oil settling system	Capacity	2400 bbl. per day	2 and size of subsurface pump
19	Type prime mover desired (gas gasoline, Diesel, electric)	19	Gas engine		Type	horizontal gravity	operator's choice

Modern dehydration



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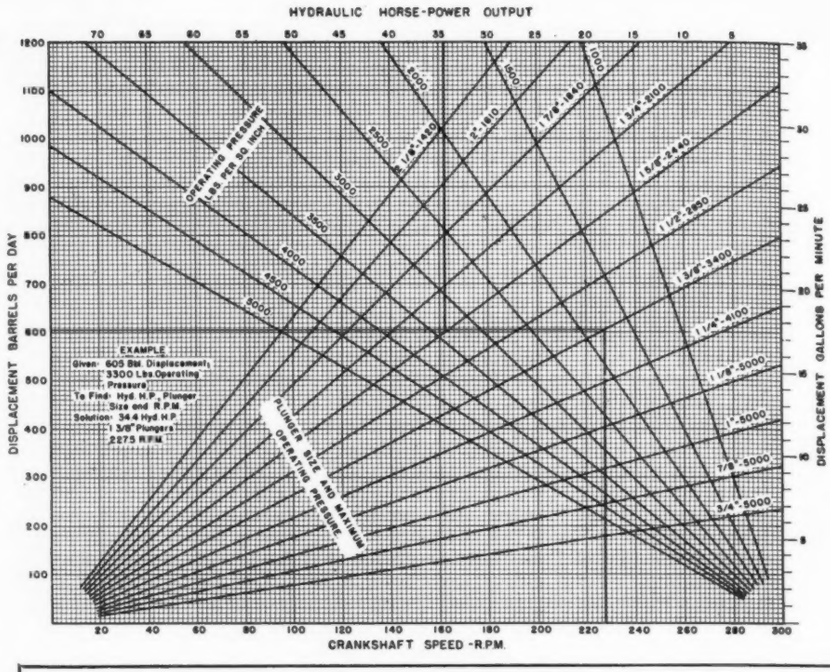
HYDRAULIC HORSE-POWER OUTPUT
DISPLACEMENT BARRELS PER DAY
DISPLACEMENT GALLONS PER MINUTE
CRANKSHAFT SPEED -R.P.M.
OPERATING PRESSURE LBS. PER SQ. INCH
PLUNGER SIZE AND MAXIMUM OPERATING PRESSURE
EXAMPLE
Given- 605 Bbl. Displacement, 3300 Lbs. Operating Pressure
To Find- Hyd. H.P., Plunger Size and R.P.M.
Solution- 34.4 Hyd. H.P.
1 3/8" Plungers
2275 R.P.M.

Fig. 5. Capacity chart—triplex power oil pumping unit

might ultimately be required if the wells should begin producing appreciable quantities of water, it was decided that the 2-in. standard subsurface pump unit of the insert type would have ample capacity. The capacity of 174 bbl. per day and other data pertaining to this unit are shown in boldface type in Table 2.

Based on past experience with 2-in. pump installations, it was recommended that 1-in. power oil lines and ¾-in. external upset power oil tubing be installed.

In establishing the requirements of the central or power unit, the assumptions as to fluid being 100 percent water of 1.1 specific gravity to be pumped from bottom were used to determine the required operating pressure, etc. The usual procedure is to use the factor of 0.5 lb. operating pressure per ft. of lift, which in this case is:

$0.5 \times 4350 = 2175$ lb. per sq. in.

Referring to the capacity chart for the triplex (3-cylinder) power unit (Fig. 5) it is found that the maximum operating pressures for 1¾-in. and 1⅝-in. plungers in the triplex pump are 2100 and 2440 lb. per sq. in., respectively. Selecting the latter size plunger, the chart further indicates that the pump capacity when the power unit is operating at 250 r.p.m. is 922 bbl. per day. This capacity corrected for 80 percent efficiency indicates a displacement capable of delivering 738 bbl. per day into the lease stock tanks, comparing favorably with the 750 bbl. daily lease allowable.

It is consistent with experience and many operators find it good practice in designing a hydraulic system to consider the displacement of the subsurface pump compared with the displacement of the surface triplex pump under actual operating conditions as being 80 percent. Also many operators consider 60 percent overall mechanical efficiency from power input to fluid delivered at the surface as a conservative figure for design purposes.

The horsepower input required may be determined as follows:

$$\text{H.P.} = \frac{(\text{ft. of lift}) \times (\text{bbl. per day}) \times (\text{sp. gr. of produced fluid}) \times (\text{wt. of fluid})}{33{,}000 \times 1440 \times (\text{overall system efficiency})}$$

$$\text{H.P.} = \frac{4350 \times 738 \times 1.1 \times 350}{33{,}000 \times 1440 \times 0.60}$$

$$= \frac{3{,}210{,}300 \times 385}{28{,}512{,}000}$$

$$= \frac{1{,}235{,}965{,}500}{28{,}512{,}000} = 43.34$$

Design of Settling System

Having determined the proper sizes for the component parts of the hydraulic pumping system, attention was then centered on the type of settling system to be installed.

The five stock tanks and the oil-gas separator were already in place on the lease. Consequently, the only tankage required to effect settling and thus obtain clean power oil were the vertical 10-ft. by 20-ft. gun barrel and the horizontal 10-ft. by 24-ft. settling tank. The vertical gun barrel would probably have been installed eventually as water production increased so that it need not be charged entirely to the settling process.

The use of a horizontal settling tank in this instance is a departure from practice in former installations but its operation has been more than satisfactory thus far.

The decision to use a horizontal rather than a vertical tank of the same dimensions, thus obtaining increased settling efficiency from the increased horizontal surface, was based on successful operation of similar methods used in oil refineries and elsewhere.

TABLE 2
Specifications—hydraulic pump

Size					Specifications									
Nominal pump size, in.		Piston diameter		Stroke, in.	Outside diameter		Pump length, in.	Approx. pump weight, lb.	Rated speed, s. p. m.	Pump displacement at rated speed, bbl./day	Displacement in bbl. per day per per s.p.m.		Ratios		Max. pump setting, ft.
Engine end	Pump end	Engine end, in.	Pump end, in.		Engine end, in.	Pump end, in.					Engine end	Pump end	E/P	P/E	
1¼	1¼	⅞–15/16	⅝	10	1²¹/₆₄	1²¹/₆₄	50	17	100	45	0.437	0.455	1.21	.827	10,000
2	2	1	15/16	12	1⅞	1⅞	78½	42	83	72	2.10	0.87	2.40	.42	15,000
2	2	1	⅞	12	1⅞	1⅞	78½	42	83	119	2.10	1.44	1.45	.69	14,500
2	**2**	**1**	**1**	**12**	1⅞	1⅞	**78½**	**42**	**83**	**174**	**2.10**	**2.10**	**1.00**	**1.00**	**10,000**
2	2	1	13/16	12	1⅞	1⅞	78½	42	83	270	2.10	3.25	.63	1.55	6,300
2	2½	1	1¼	12	1⅞	2⅜	92	64	83	304	2.10	3.67	.57	1.75	5,700
2	2½	1	1⁷/₁₆	12	1⅞	2⅜	92	64	83	422	2.10	5.09	.46	2.19	4,600
2½	2½	1¼	1	18	2⅜	2⅜	105	85	71	182	4.92	2.56	1.92	.52	15,000
2½	2½	1¼	1⅛	18	2⅜	2⅜	105	85	71	261	4.92	3.67	1.34	.75	13,400
2½	2½	1¼	1¼	18	2⅜	2⅜	105	85	71	349	4.92	4.92	1.00	1.00	10,000
2½	2½	1¼	1⁷/₁₆	18	2⅜	2⅜	105	85	71	500	4.92	7.03	.70	1.43	7,000
2½	3	1¼	1½	18	2⅜	2 5/16	121	127	71	554	4.92	7.80	.63	1.59	6,300
2½	3	1¼	1¾	18	2⅜	2 5/16	121	127	71	796	4.92	11.20	.44	2.28	4,400
3	3	1½	1	24	2¹³/₁₆	2¹³/₁₆	136½	168	64	157	9.44	2.45	3.86	.26	15,000
3	3	1½	1¼	24	2¹³/₁₆	2¹³/₁₆	136½	168	64	358	9.44	5.59	1.69	.59	15,000
3	3	1½	1⅜	24	2¹³/₁₆	2¹³/₁₆	136½	168	64	475	9.44	7.43	1.27	.79	12,700
3	3	1½	1½	24	2¹³/₁₆	2¹³/₁₆	136½	168	64	604	9.44	9.44	1.00	1.00	10,000
3	3	1½	1¾	24	2¹³/₁₆	2¹³/₁₆	136½	168	64	896	9.44	13.99	.68	1.43	6,800
3	4	1½	2	24	2¹³/₁₆	3¾	155	269	64	1,230	9.44	19.23	.49	2.04	4,900
3	4	1½	2⅜	24	2¹³/₁₆	3¾	155	269	64	1,820	9.44	28.41	.33	3.01	3,300
4	4	2	1½	30	3¾	3¾	173	370	57	498	21.0	8.74	2.40	.42	15,000
4	4	2	1¾	30	3¾	3¾	173	370	57	822	21.0	14.42	1.46	.69	14,600
4	4	2	2	30	3¾	3¾	173	370	57	1,200	21.0	21.00	1.00	1.00	10,000
4	4	2	2⅜	30	3¾	3¾	173	370	57	1,850	21.0	32.45	.65	1.55	6,500
4	6	2	3	30	3¾	5½	204	726	57	3,190	21.0	55.95	.38	2.68	3,800
4	6	2	3½	30	3¾	5½	204	726	57	4,485	21.0	78.68	.27	3.75	2,700
6	6	3	3	33	5¹¹/₁₆	5¹¹/₁₆	240	1150	54	2,800	52.0	52.00	1.00	1.00	10,000
6	6	3	3½	33	5¹¹/₁₆	5¹¹/₁₆	240	1150	54	4,150	52.0	76.9	.68	1.48	6,800

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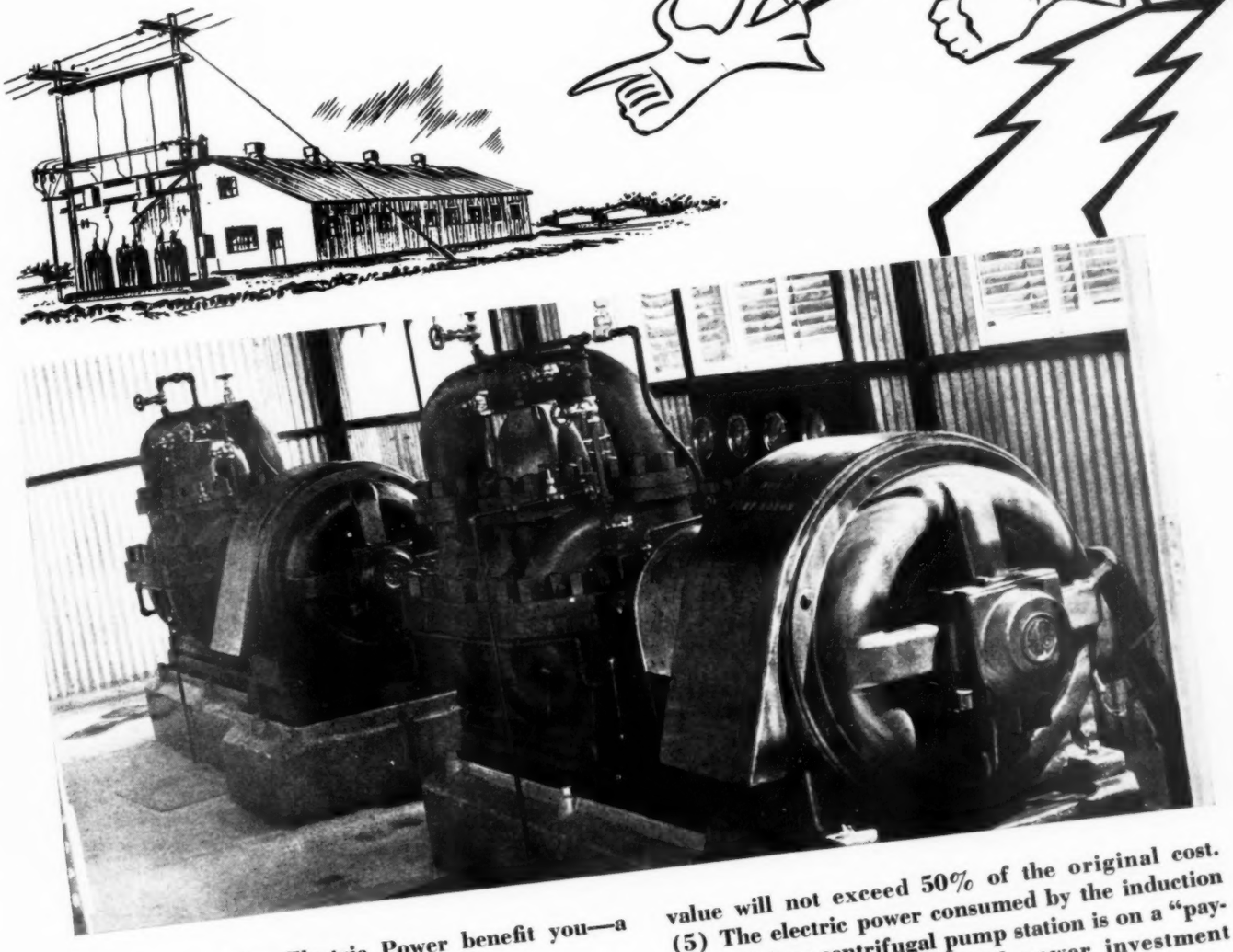

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Fig. 6. Showing relative position of triplex pumps with respect to control manifold. Pumps were subsequently housed. (See Fig. 1)

Flow of Oil in System

The fluid produced from the wells, including the spent power oil, is gathered and delivered to the central plant through the gathering system already serving the wells prior to the pumping installations.

The total volume of fluid produced first enters the elevated gas-oil separator. The fluid, after the gas is separated, gravitates to the base of the vertical gun barrel, containing 6 ft. of water, through which the oil is washed as it passes upward in the tank. Additional gas coming out of solution in the gun barrel is removed through the outside gas separator or boot.

TABLE 3
Normally recommended power oil tubing

Nominal size of engine end of subsurface unit	Minimum size power oil tubing normally used to operate subsurface pump to capacity
2-in.	¾-in.
2½-in.	1-in.
3-in.	1¼-in.
4-in.	2-in.

Only that quantity of the oil produced that is required to supply the power unit enters the horizontal settling tank from the vertical gun barrel. The rest of the oil passes directly to the stock tanks. Thus, only a relatively small volume of the total oil is subjected to conditioning as power oil. The effective settling time in such a large vessel as the horizontal tank is thus materially increased.

The inlet to the settling tank is perpendicular to the axis of the tank on top at one end of the tank and the outlet or suction line to the triplex pumps is at the other end, 2 ft. from the top and parallel to the tank axis. Consequently, the oil enters the tank in a downward direction, then has its flow altered to horizontal and is withdrawn 2 ft. from the top on the other end.

Fig. 7. Showing extreme simplicity of wellhead equipment. Special top flange provides streamlined outlet to flow line. Power oil enters through upper connection

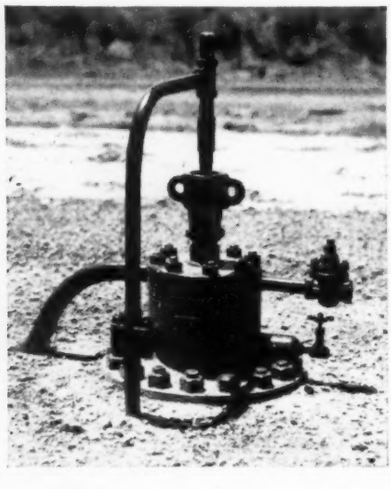

TABLE 4
Central plant triplex pump ratings

Size	Type drive	Maximum crankshaft r.p.m.	Maximum displacing capacity, bbl. per day	Maximum rated horsepower output
2-B	Electric	188	250	7.5
2-B	Gas engine	350	450	12.5
3-C	Electric	163	700	25.0
3-C	Gas engine	300	1200	40.0

The manifold into which the triplex pumps discharge the power oil is so arranged that all individual well lines may be supplied by either of the two pumps or both.

Each of the vertical 1-in. risers shown in Fig. 6 represents an individual well line, serving each of the 20 wells on the lease. The lower valve on each vertical riser is a master gate and the upper valve is graduated for control purposes. Each line is equipped with an indicating pressure gauge.

The decision to install individual power oil lines from the central plant rather than employ larger field lines with controls situated at each wellhead was for the obvious advantage of centralizing control. One operator may close or open or adjust the flow of any of the 20 wells without leaving the central plant site.

The interior walls of the 1-in. lines connecting the central plant with the wellheads as well as of all ¾-in. power oil tubing were thoroughly sandblasted before being shipped in order to remove all mill scale and other particles that might score or clog the hydraulic engine parts.

Pumping Schedule

As indicated earlier, one 3-cylinder triplex pump was considered adequate to pump the present allowable when operated on a 24-hr. basis. In order to pump this volume of oil within an 8-hr. tour, thus reducing the number of operations required, two 3-cylinder triplex pumps were installed. At present, all wells are producing the 24-hr. allowable on a 7-hr. schedule.

THE NEW OTIS PRESSURE LOCK PACKER

Positively THE MOST *SECURELY LOCKED* . . . THE MOST *EASILY REMOVED* PACKER EVER PRESENTED THE INDUSTRY

Because

1. Only ONE SET OF SLIPS is used to positively lock packer against both UPWARD and DOWNWARD thrust.
2. Contains GREATER SLIP AREA than conventional packer . . . eight individual slips make slip area more effective and flexible.
3. Slip assembly is COMPLETELY PROTECTED from sand, shale, etc., by the preset packing elements.
4. Packer can be jarred loose when pulling by lowering the tubing a limited distance and running into the lower end of packer to drive the tapered mandrel from between the slips.

Other Important Features

1. The GREATER the PRESSURE, the TIGHTER the SEAL and the more secure the lock. This is made possible by utilizing the well energy to effect a positive seal and expand the slips.
2. Packer can be SET AT SHALLOW DEPTHS (100' to 1,000') with full effectiveness, and, in the event of damage to surface connections, will not blow out of hole.
3. Preset pressure seal packing shuts off equally as well against 1 p.s.i. as against 7,000 p.s.i.
4. Natural shape of packing elements causes seal—neither weight of tubing nor pressure differential is necessary to cause packing elements to expand.
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Automatic Closing Valve Developed for Gas Transmission Lines

Exclusive

☆ New type valve unaffected by normal line fluctuations— Has long distance control over line breaks

by Edwin E. Hedene
Chief Engineer, Merco Nordstrom Valve Company

PIPE-LINE construction is headline news in these days of national defense. Shortage of tankers and tank cars emphasizes the need for pipe lines. Because transmission of gases through pipe lines has grown to great magnitude it takes its place as an essential and necessary means for economical transportation in many of the basic industries.

Such transmission pipe lines often traverse long distances, over difficult terrain and oftentimes are subjected to the destructive effects of storms floods, washouts, etc. For years both the executives and engineers of gas pipe line companies have been confronted with the problem of providing greater protection for their pipelines than that which could be obtained by merely using the shutoff valves customarily installed.

One of the major gas pipe line companies experimented with check valves without satisfactory results. Then both motor- and gas-operating equipment were tried on their present installed gate valves, but proved impracticable due to the high differential pressures involved. The requirement was for a valve and control system that would not be affected by normal line pressure fluctuations due to service demands, yet would close automatically in case of a line break on either side of the valve, remaining closed until manually reopened and still be manually operated when so desired, independent of the automatic control system.

EDWIN E. HEDENE

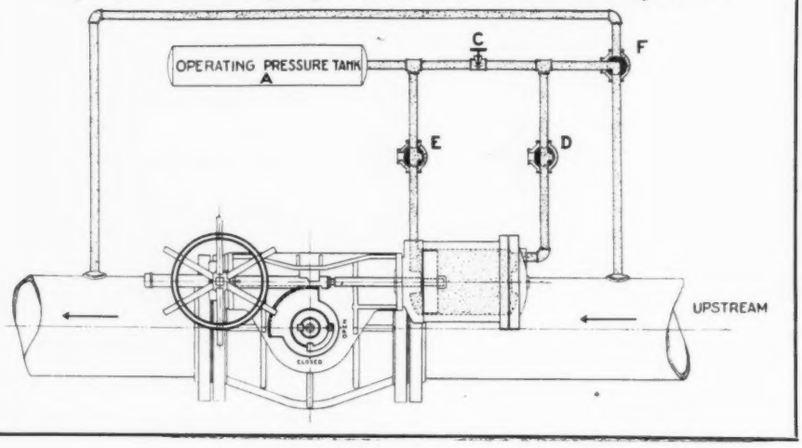
received his engineering education at the University of California—Was design engineer and chief engineer for the Standard Gas Engine Company, 1919-21—In charge of engineering department of Doble Steam Motors, 1921-26—In 1926 he joined the staff of Merco Nordstrom Valve Company as an engineer, being advanced to chief engineer in 1933—Is in charge of all phases of valve design, installation, and use of Nordstrom Valves.

New Valve and Control System

The Merco Nordstrom Valve Company, in conjunction with the engineers of this pipe line company, has developed such a valve and control system to accomplish this purpose. The valve and control system, which has proved satisfactory, is illustrated in Fig. 1, which shows the valve in the open position and set for automatic operation. Essentially it consists of a Nordstrom Hypreseal valve, piston-operated with the piston and piston rod connected to a sliding rack engaging with a segmental gear attached to the operating stem of the valve. Longitudinal motion of the piston in the cylinder transmitted through the operating mechanism, rotates the plug in the valve either to close or open the valve, thus controlling the flow of fluid in the main pipe line. A suitable operating pressure tank is provided, which is connected to the upstream side of the main pipe line and "floats" on the pressure system. The cylinder of the piston-operated valve has two connections; viz: one connection from below the piston to the operating pressure tank, the other connection from the top of the piston to the pipe connecting the main pipe line to the operating pressure tank, with an orifice or choke "C" placed between this latter connection and the operating pressure tank to restrict the flow of fluid in or out of this tank.

An additional connection joining the operating pressure tank to the main pipe line downstream from the main valve may be provided to supply pressure to the operating pressure tank when a break has occurred upstream from the main valve. Such a break will not only automatically close the main valve, but will allow the pressure in the broken main line, operating pressure tank, and cylinder to become exhausted. By turning the multiport valve "F" to close off the con-

Fig. 1. Valve in the open position and set for automatic operation

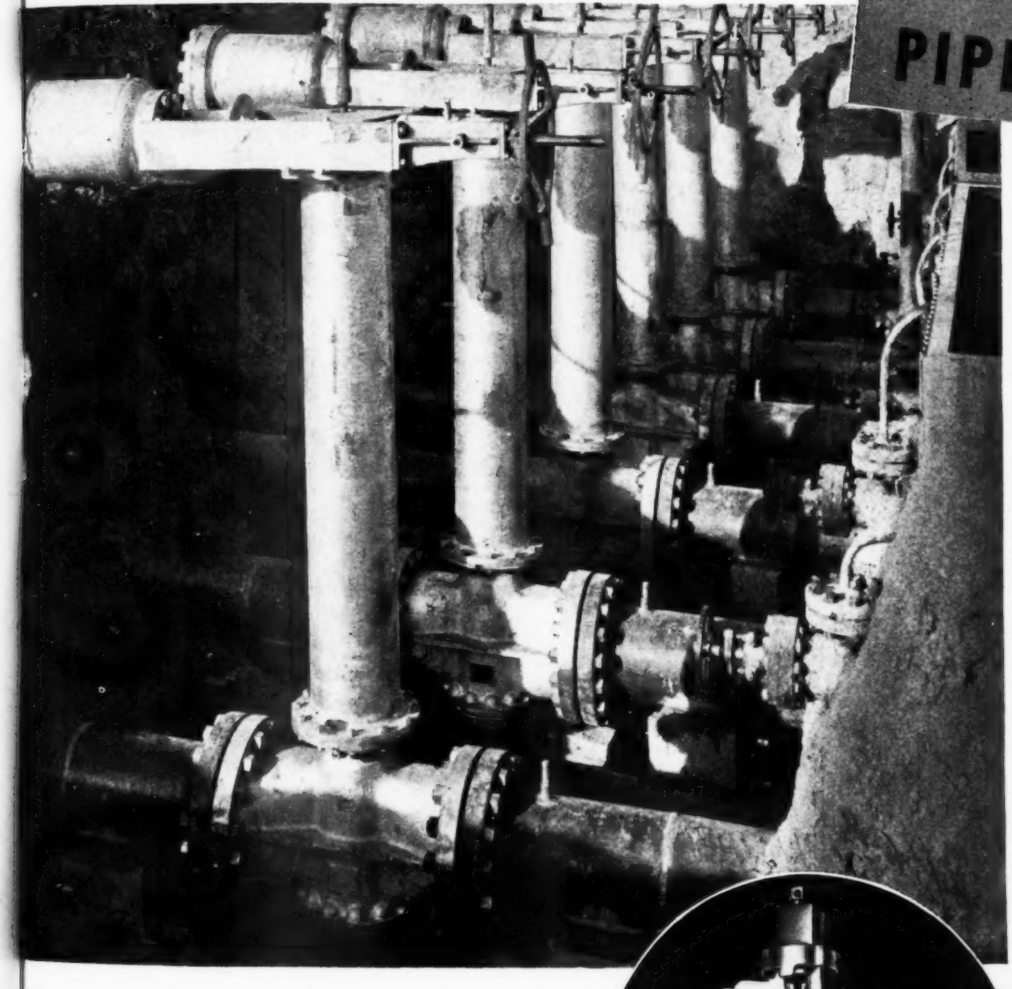


PREPARE *for* EMERGENCIES

Completed Installation of Nordstrom 12" Automatic Pipe Line Valves at a river crossing.

BELOW: View of same installation before excavation was backfilled. The valves are buried approximately four feet underground, with cylinder control equipment above ground.

NORDSTROM *Lubricated* VALVES *provide* QUICK, AUTOMATIC CONTROL *for* PIPELINE SERVICE

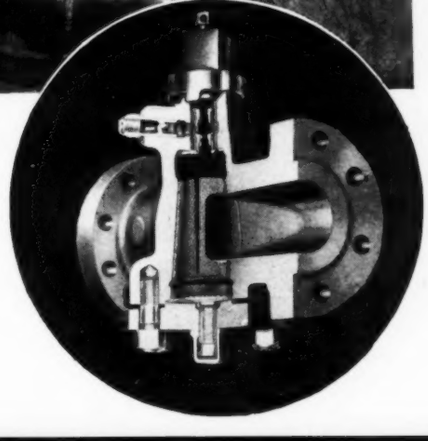


Failure of a valve to close in case of an emergency shut-off can cause irreparable damage. Use of Nordstrom Valves all along the line is a protection which positively insures quick, safe control by manual or automatic operation.

Where pipe lines traverse long distances, over remote territory, or where subjected to destructive effects such as storms, floods, bridge washouts, etc., such valves may save tens of thousands of dollars. Distant breaks in the line — 30, 40, 50 or more miles away—will actuate these valves by reason of the sensitive control arrangement.

Here is pictured a typical installation of Nordstrom Hypreseal Automatic Closing Valves. They will close automatically in case of a line break on either side. They are unaffected by normal line fluctuations due to service demands. Such valves will remain closed until manually reopened and also can be manually operated, when desired, independent of the automatic control system.

The Nordstrom Engineering Department has developed comprehensive data on the development and application of Nordstrom Lubricated Valves for pipe line service, which is available to interested companies, upon request.



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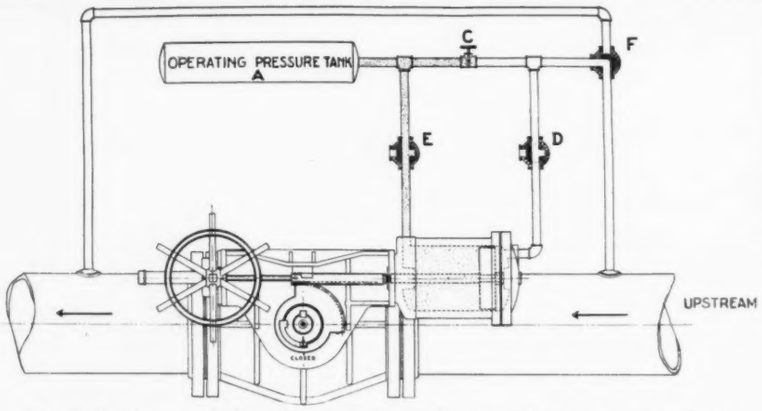

Fig. 2. Positions of the piston, rack, and segment after an automatic closing operation has occurred

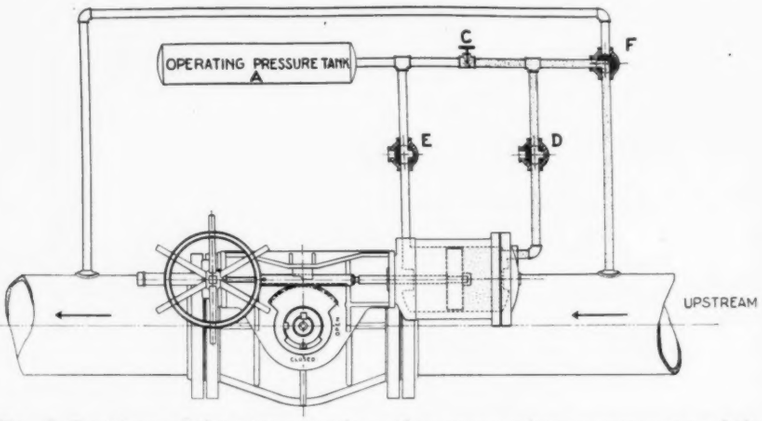

Fig. 3. Positions of the piston, rack, and segment when repressuring of the operating pressure tank system occurs with the main valve closed and the pipe-line rupture downstream of closed valve

nection to the upstream side of the valve and to connect the downstream side of the valve to the pressure operating tank, pressure from the downstream connection can be used to reopen the main valve when required. For manually controlling the power-operated mechanism when desired, the multiport valves "D" and "E" are used, which allow the operator to exhaust either side of the piston as desired to cause the opening or closing of the main valve. The normal positions of these valves "D" and "E" are shown in Fig. 1. Manual means, in addition to the power-operated means, have been provided to permit the direct mechanical operation of the valve without resorting to pressure whenever required.

Operation

In theory and actual practice, should the pipe line rupture either upstream or downstream from the open main valve, the resulting rapid decrease of pressure in the main line at the main valve will produce a similar reduction of pressure in the cylinder above the piston and because of the restriction through the orifice "C", the pressure in both the operating pressure tank and in the cylinder under the piston will not drop so rapidly as that in the main pipe line, thus creating a differential pressure across the piston sufficient to move it and close the main valve. A novel type of connection between the segment gear and the valve stem is employed, which only permits closing of the main valve when set for automatic closing operation.

Fig. 2 illustrates the positions of the piston, rack, and segment after an automatic closing operation has occurred.

Fig. 3 illustrates the positions of the piston, rack, and segment when repressuring of the operating pressure tank system occurs with the main valve closed and the pipe line rupture downstream of the closed valve. The repressuring of the control system causes the piston, rack, and segment to return to their normally open position without rotating the plug stem and with the main valve remaining closed.

Fig. 4 illustrates the positions of the piston, rack, and segment preparatory to reopening the main valve by power, after repairs to the ruptured pipe line have been completed. The valve "D" is turned to disconnect the operating pressure tank and to exhaust the pressure in the cylinder above the piston. The piston is then moved by the pressure in the operating pressure tank to the extreme outboard position as shown in Fig. 4, at which time the slip key "J" is placed to connect the segment rigidly to the plug operating stem.

Fig. 5 illustrates the positions of the piston, rack, segment, and valve reopening under pressure. The valve "D" is turned back to reconnect the operating pressure tank to the cylinder and the valve "E" turned to disconnect the operating pressure tank to the cylinder and to exhaust the cylinder under the piston to the atmosphere, thus admitting pressure through valve "D" to the top of the piston to reopen the main valve. With the main valve fully open again, the slip key "J" is removed and the valve "E" is returned to its normal operating position as shown in Fig. 1, thus leaving the main valve and control system again set for automatic closing. Should the line break

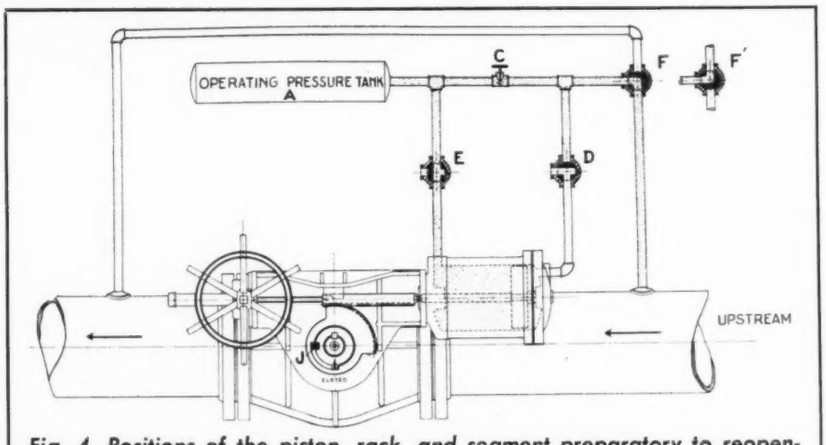

Fig. 4. Positions of the piston, rack, and segment preparatory to reopening the main valve by power, after repairs to the ruptured pipe line have been completed

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The improved Kinzbach Rotary Slips, pictured above, are safely handling more than 2¼ miles of drill pipe. They will safely handle the longest strings of today's . . . and tomorrow's . . . deeper drilling, because into them are built the greatest strength, flexibility and other features of safety found in rotary slip design. The load is evenly distributed over the entire gripping surface because each insert is individually anchored to the slip segment. Six-piece construction provides maximum flexibility, and the design of these segments assures as near perfect wedging action as is possible. Nine broadfaced inserts in each segment provide true contact, regardless of inconformities of outer wall of the pipe . . . or misalignment.

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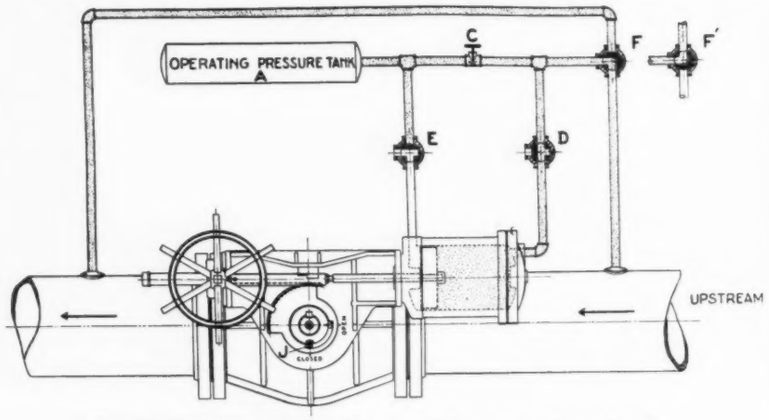

Fig. 5. Positions of the piston, rack, segment, and valve reopening under pressure

occur upstream of the main valve and all pressure dissipated from the operating tank and control system, then by rotating valve "F" to the position "F", the pressure from the downstream side of the closed valve can be utilized to reopen the main valve.

Fig. 6 illustrates the mechanical operating mechanism to open or close the main valve independent of any power means. With the slip key "J" in place, valves "D" and "E" are turned to vent both ends of the cylinder to the atmosphere and to disconnect the operating pressure tank from the cylinder. A connecting pin "M" is placed to join the rack "N" to the operating screw "L" and the main valve may now be operated manually either to open or close as desired.

Equipment Selected for Tests

For the initial experimental work, a 12-in. Nordstrom Hypreseal cast-steel valve, Fig. No. 4449, was used with both the valve and cylinder designed for 800 lb. per sq. in. working pressure, 1200 lb. per sq. in. test pressure. The piston size was chosen to operate the valve with 100 lb. per sq. in. maximum differential pressure across the piston. The first tests demonstrated that the valve would close with 40 lb. per sq. in. to 50 lb. per sq. in. differential pressure across the piston with 651 lb. per sq. in. on the upstream side of the plug and atmospheric pressure on the downstream side. Additional tests were made to determine the responsiveness of the valve and control system when line breaks occurred at increasing distances from the valve setting. Such tests were made by determining the effect of the position of a line break in respect to the valve setting.

Fig. 7 was prepared to show the time required for the main-line pressure to drop 100 lb. per sq. in. at the valve setting, with assumed main-line failure occurring at varying distances from the valve setting. Tests were made by varying the rate of pressure drop at the valve setting to simulate pipe-line breaks at varying distances from the valve setting.

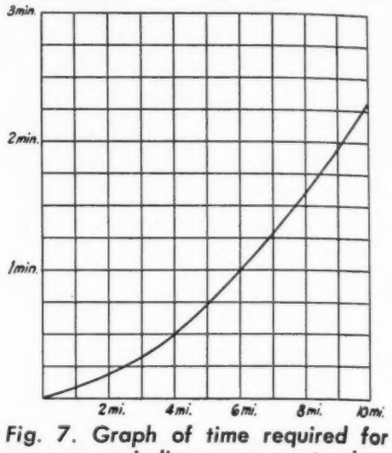

Fig. 7. Graph of time required for average main-line pressures to drop 100 lb. at a valve setting in case of a main-line failure at various distances from the valve setting

Table 1 is a summary of these initial tests.

TABLE I

Pressure in system, lb.	Pressure drop required to start closing of valve, lb.	Pressure drop required to complete closing of valve, lb.	Time required to close	Approximate distance of valve from main line break, miles
675	50	100	24 sec.	5
674	64	94	30 sec.	6
674	59	154	1 min. 31 sec.	8½
654	44	134	45 sec.	8½

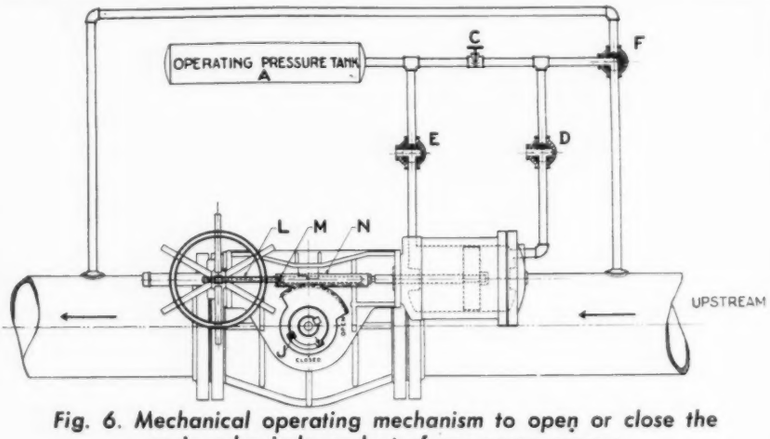

Fig. 6. Mechanical operating mechanism to open or close the main valve independent of any power means

Test Data

These first tests demonstrated that the valve and control system would be responsive to breaks as remote as 8½ miles from the valve setting and it was decided to continue the tests to determine whether the valve and control system would be responsive to breaks ocurring at greater distances than 8½ miles from the valve setting. Five more valves identical with the first were subsequently installed at one of the company's river crossings, which then consisted of six 12-in. lines manifolded together and so arranged that further tests could be run. The amount and rate of pressure drop necessary on the pipe line at the valve setting to cause the valves to close were then determined. It is obvious that if the break was close to the automatic valve setting, the pressure drop in the pipe line at the valve setting would be rapid and closing would occur almost instantly, but as the assumed position of the pipe-line break moved farther away from the valve setting, the rate of pressure drop in the pipe line at the valve setting would be slower and more of the reservoir pressure would be spent, thereby increasing the time

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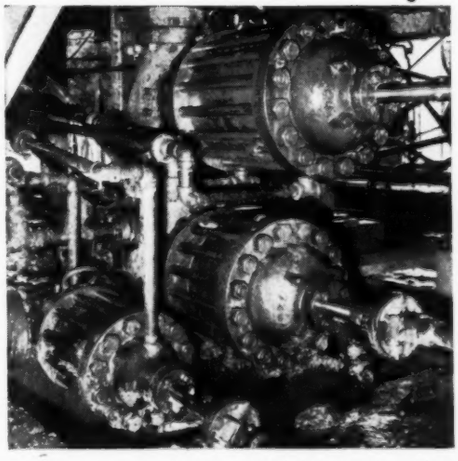
Instant Closure—pressure supplied by boiler feed pump, slush pump, or both, remotely controlled from the derrick floor, closes rams and ram gate instantly.



Surface view of a typical 10,000′ Gulf Coast wildcat —Cameron Series 900 A.P.I. 6000-lb. Test Pressure Operated Blowout Preventer and Type DV Master Gate and Flowline Gate Valves.

Positive Seal—Patented self-feeding packing elements in blowout preventer rams effect a positive seal the instant closing pressure is applied. Ample reserve of resilient packing material permits rotating and moving pipe in hole safely under pressure. Self-feeding packing element in valve ram gate automatically feeds out and effects a pressure-tight seal even though the seat should be roughened, corroded or sand cut.

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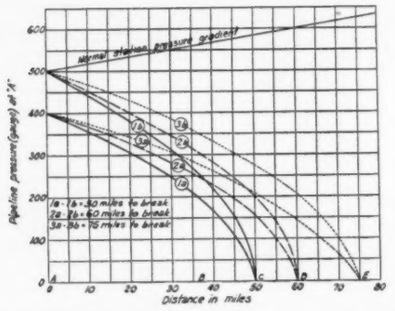

Normal station pressure gradient
Pipeline pressure (gauge) at "A"
1a - 1b = 50 miles to break
2a - 2b = 60 miles to break
3a - 3b = 75 miles to break
Distance in miles

Fig. 8. Pressure gradients on pipe line at various distances from "A" during breaks on line at 50, 60, and 75 mile points from "A"

required to close the valve.

During such an assumed break in the pipe line, at varying distances from the automatic valve setting, the rate of pressure drop will vary according to two variables:

1. The distance of the valve setting from the dead end of the pipe line.
2. The distance of the assumed break from the valve setting.

Fig. 8 is a chart showing the pressure gradients on the pipe line calculated at the instants the pressure at "A" were 500 and 400 lb. gauge. Three cases were considered: breaks at 50, 60, and 75 miles from "A" or 14, 24, and 39 miles from the valve setting. The valve setting is located at point "B", or 36 miles from "A".

The calculations for the data in plotting the curves in Fig. 8 are arrived at as follows: Weymouth's formula, $Q = K\sqrt{\frac{P_1 - P_2}{L}}$ is used, where Q = cu. ft. of gas flow per 24-hr. day; K = the constant for 24-in. O. D. pipe line = 3,683,000; P_1 = initial pressure (absolute); P_2 = final pressure (absolute), and L = length in miles. Q is solved for using P_1 as 515 lb., P_2 as 15 lb., and L as 50 miles. With this value of Q, calculations are made for P_2 with L as 36 miles (Station "B"). This gives the three essential pressure points on the curve, i. e., 500, 260, and 0 lb. gauge for the 0-, 36-, and 50-mile points. The points on the other curves are solved for in a similar manner.

Fig. 9 is a chart showing the time required for the pressure to drop 100 lb. at "A" during a main line break at varying distances from "A", and is based on the actual rate of pressure drop recorded from previous pipe-line breaks. For example, with a break 50 miles from "A", 35 minutes was required for the pressure to drop 100 lb. at "A".

Referring again to Fig 8 (curve for the 50-mile break: 1a-1b) the time element is the same for a 500-lb. to 400-lb. drop at "A" as it is for a 55-lb. drop at "B" (260-205 lb. range). Therefore, in the 50-mile break case at "B", the pressure drops 55 lb. in 35 minutes (260-205 lb.). These data give the slope of the curve in Fig. 10 between 260 lb. and 205 lb. where pressure drop in lb. is plotted against minutes of time. The rate of change of the curve is taken from the experimental data. By trial the curve is plotted so it will satisfy the rate of change from the experimental data and the slope of the curve arrived at above.

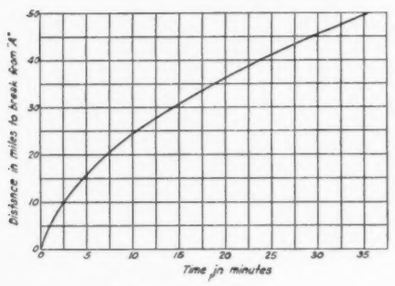
The same procedure was used for calculating the 60- and 75-mile curves (No. 2 and No. 3, Fig. 10). In the 60-mile case, the time element at "B" is 42 minutes for a 62-lb. drop. In the 75-mile case the time element at "B" is 60 minutes for a 73-lb. drop.

Fig. 11 is a graph prepared to show the relationship between pressure drops in the pipe line and the time for closing the automatic valve. These data are from experimentation. When the pressure drop is rather sudden, the valve will close with a 55-lb. average pressure drop in the pipe line. As the rate of pressure drop in the pipe line becomes slower, the time required for the valve to close is increased. The relationship is plotted as a straight line on the graph shown in Fig. 11.

By using graphs Fig. 10 and Fig. 11 in conjunction, the determination was made of the time required for the valves at point "B" to close. By using the 50-mile curve, it was found that the valve setting pressure drop was approximately 57 lb. in the first two minutes after the break. These time and pressure conditions also satisfy the graph in Fig. 11. Consequently, if the pressure at the valve setting "B" was 560 lb. initially, then when a break occurred 50 miles from "A" or 14 miles from "B", the automatic valve would begin to close in two minutes, at which time the line pressure at the valve setting would have dropped to approximately 503 lb. gauge.

If the break were 60 miles from "A" or 24 miles from valve setting "B", the automatic valve would begin to close in four minutes, at which time the line pressure in the valve setting would have dropped to 502-lb. gauge or a 58-lb. pressure drop. Considering the break 75 miles from "A" or 39 miles from valve setting "B", the automatic valve would begin to close in approximately nine minutes, at which time the line pressure in the valve setting would have dropped to 500-lb. gauge or a 60-lb. pressure drop.

Fig. 9. Graph showing time required for pressure to drop 100 lb. at "A" (500 lb. to 400 lb. range) during a main-line break. Data from previous pipe-line breaks



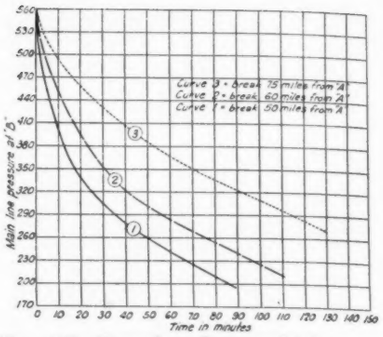

Curve 3 = break 75 miles from "A"
Curve 2 = break 60 miles from "A"
Curve 1 = break 50 miles from "A"
Main line pressure at "B"
Time in minutes

Fig. 10. Graphs along which pressures drop at "B" automatic gate setting for various time intervals during three imaginary breaks. The 24-in. pipe line is assumed as open to the atmosphere. Based on experimental and calculated data

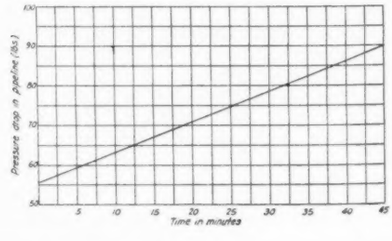
Conclusions

These comprehensive tests definitely proved that both the Nordstrom Valve and Control System were responsive to line breaks as remote as 39 miles or more from the valve setting and would, under the latter conditions, begin to close in approximately nine minutes, when a pressure drop of approximately 60 lb. at the valve setting existed.

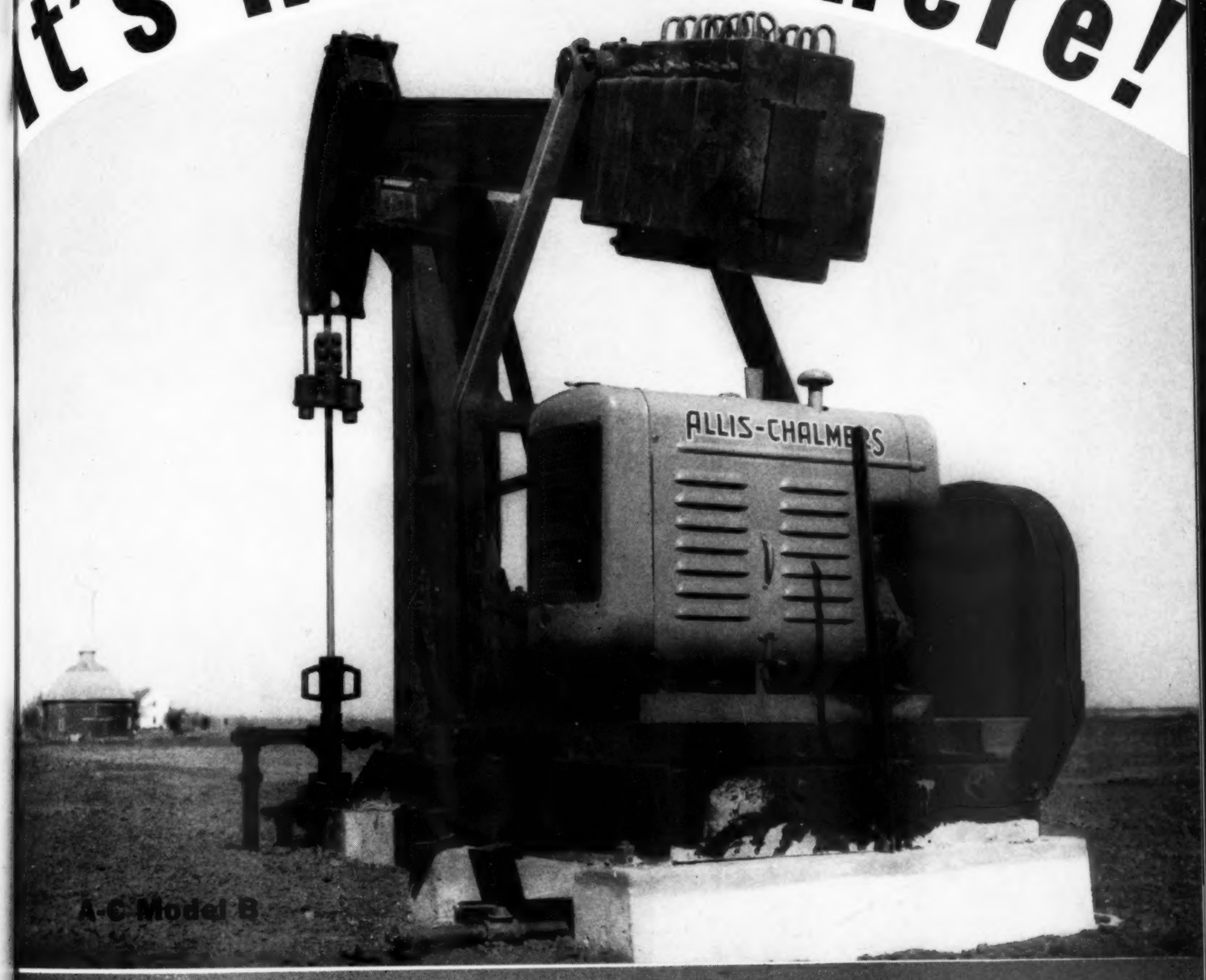
The automatic closing valve is now being manufactured in sizes 12 in. to 24 in. inclusive, and can be supplied at any pressure rating from 250 lb. to 1000 lb.

Nordstrom valves and automatic control system may be applied to both main pipe lines and to branch lines to afford maximum protection for the transmission system.

Fig. 11. Graph showing time in minutes required for automatic valves to close when the rate of pressure drop varies, thus causing the amount of pressure drop in the pipe line to vary also. The data are from actual tests



t's HOT out here!



A-C Model B

that's why you see so many

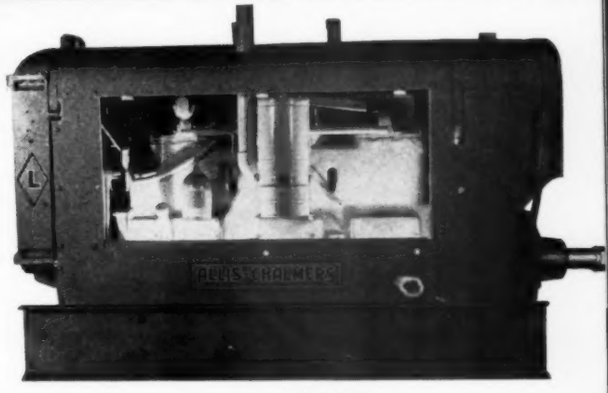
A-C ENGINES

Low cost *per barrel lifted* — regardless of temperatures — that's built into Allis-Chalmers Engines.

Tractor type COOLING and LUBRICATING systems will stand-up under gruelling heat. Temperatures are controlled for most efficient operation—this is reflected by low oil consumption, and long service without parts replacement.

Prove to yourself that Allis-Chalmers engines are properly cooled the next time you drive by one running—lay your hand on the back of the rear cylinder—you won't get burnt!

FIVE MODELS for stationary power use: Model L, torque 590 ft. lbs. Model E, torque 400 ft. lbs. Model U, torque 200 ft. lbs. Model W, torque 128 ft. lb. Model B, torque 74 ft. lbs.



A-C Model L

Electric generating plant in Rincon field, California

Exclusive Feature

by

Wallace A. Sawdon

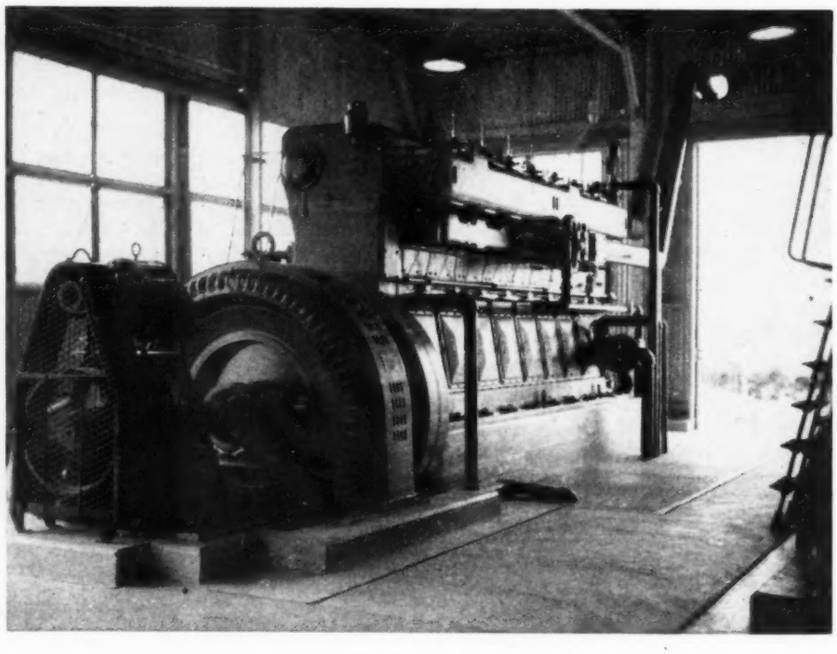
Pacific Coast and Foreign Editor

Electric Generating Plant Supplies Power for Lease Operation

☆ Oil company uses electric power for rotary drilling, pumping, and cooling in Rincon field, California—Power transmitted to all parts of field

IN ADDITION to providing economies in field operations, a new electric generating plant recently completed by the Chanslor-Canfield Midway Oil Company in the Rincon field, California, has released power for consumption that may possibly be in future demand for servicing the rapidly growing defense industries of the state. Water is a big problem in this field and the company has long used electrical power for drilling to conserve water. The plant was thus designed to take care of all normal drilling and production demands, but since its construction there has already been talk of power shortage. If such a shortage should occur in this part of the state the company is now in a position to carry on operations under any emergency.

The Chansler-Canfield Midway Oil Company is an electrically-minded organization and has been a pioneer in the use of electric motors for rotary drilling. The first well to reach a depth of 10,000 ft. was drilled by the company in 1931 with electric power. It has also been one of the pioneers in the use of electrical pumping equipment and has done a great deal of research work in the application of slow pumping for stripper wells. Thus it is experienced in methods to make effective use of electric power. The company has for some time been considering the installation of a generating plant to



Each of the four generating units consists of an 8-cylinder Diesel-convertible gas engine direct-connected to a 400-kw., 500-kva. generator

. . . to CABLE-TOOL PROBLEMS

Wherever cable-system drilling and fishing tools are used, SPANG CABLE TOOLS set the standards. Yet—Spang's value to the oil and gas industry goes far beyond the manufacture of the tools themselves.

Beginning about half a century ago, this company has broken the ground in developing many of the drilling methods that today are standard practice. Spang has pioneered in the development of new tools to meet new conditions, and in the improved efficiency of almost every cable tool. Spang's activities have had a share in making the Cable System—although the oldest drilling method—still the most efficient in a large percentage of present locations.

That experience—accumulated over a 47-year period—is the reason *Spang has the answers* to your cable-tool problems. Feel free to consult us whenever you need expert advice.

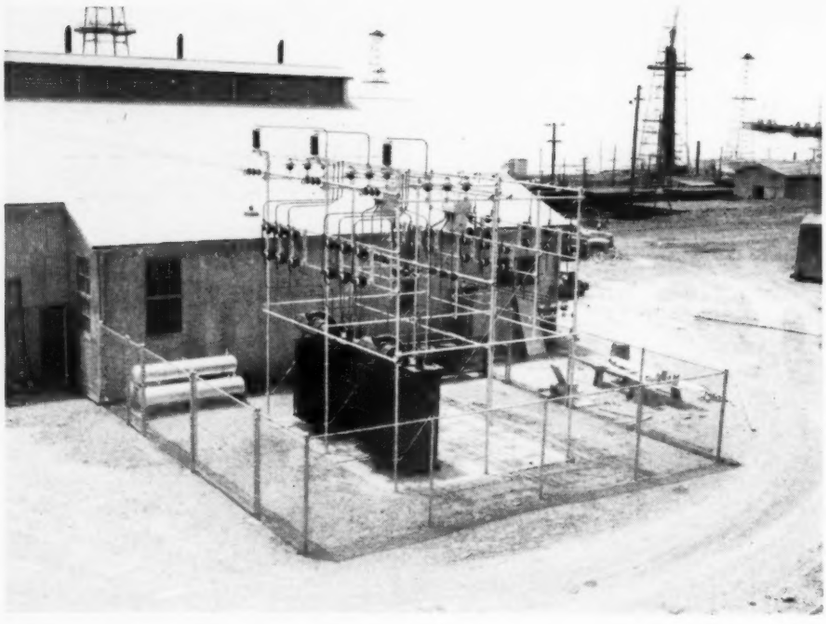
SPANG & COMPANY, Butler, Pa.

SPANG

THE BIGGEST CABLE TOOLS NAME IN

The HIGHER STANDARD

In drilling a well, the fundamental problem still remains one of economy. Compare all costs *before* you drill — then choose the drilling method that is best for each particular job. If it's the cable system, remember that Spang Tools offer the greatest value for your money.



Transformers and distribution rack

provide electric power for the operation of its leases in the Rincon field and this newly completed plant is the result.

Economy of operation and conservation of gas have naturally been important factors in the decision to install the electric generating plant. The company has its own fuel and is now burning some of its own products that could not previously be utilized. Power at low cost can thus be generated with the plant situated at the point of load. Line losses in distribution and transmission are eliminated. Only the company's own men are employed in operation of the plant and total control of operation is within the company organization.

The plant was designed and engineered by CCMO and the installation of all equipment was by the company's personnel. Although there were a few minor delays in receipt of equipment, the construction and installation moved like clock-work and according to plans. In selecting the equipment, long service with minimum maintenance was given primary consideration. Prime movers of the slow-speed, Diesel-convertible type were therefore chosen, and although these increased the original investment they provide the desired low upkeep cost and long life. The generators and switchboard equipment are of the most modern design and are capable of handling overloads.

Four Generating Units

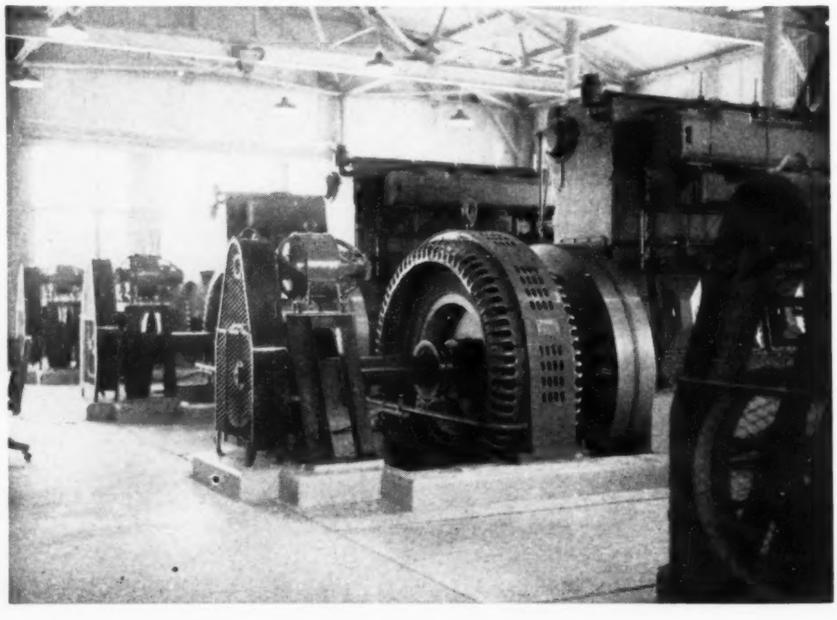
There are at present four generating units, each powered by an 8-cylinder, 600-hp. Diesel-convertible engine operating at 400 r.p.m. on gas from the field. Each engine is direct-connected to a 400-kw., 500-kva. generator with 80 percent power factor. The exciter, operating at 1450 r.p.m., is driven through V-belts from the direct-connected generator shaft. The higher speed exciter is used in order to provide better regulation of voltage.

Current is generated at 2400 volts, 60 cycles. All lines pass through underground conduits to the switchboard and through individual generator switches to switchboard bus bars. From there the current goes through the master distribution switch, which is connected by copper tubing to the transformers and distribution rack situated immediately behind the plant building.

Some of the power is taken off at 2400 volts to supply the electrically-driven facilities in the area adjacent to the plant. A portion of the load is stepped up to 16,500 volts for servicing more distant operations. This current goes direct to a substation where it is delivered to three 16,500-volt circuits. The maximum transmission distance at present is approximately six miles and this power is used for pumping and handling of crude at all distant points. Drilling power at all locations on the leases is delivered at 16,500 volts as all transformers on hand for drilling wells are for stepping down 16,500-volt current to 440 volts. The present power transmission system can handle any future drilling at any place on the company's leases in this district.

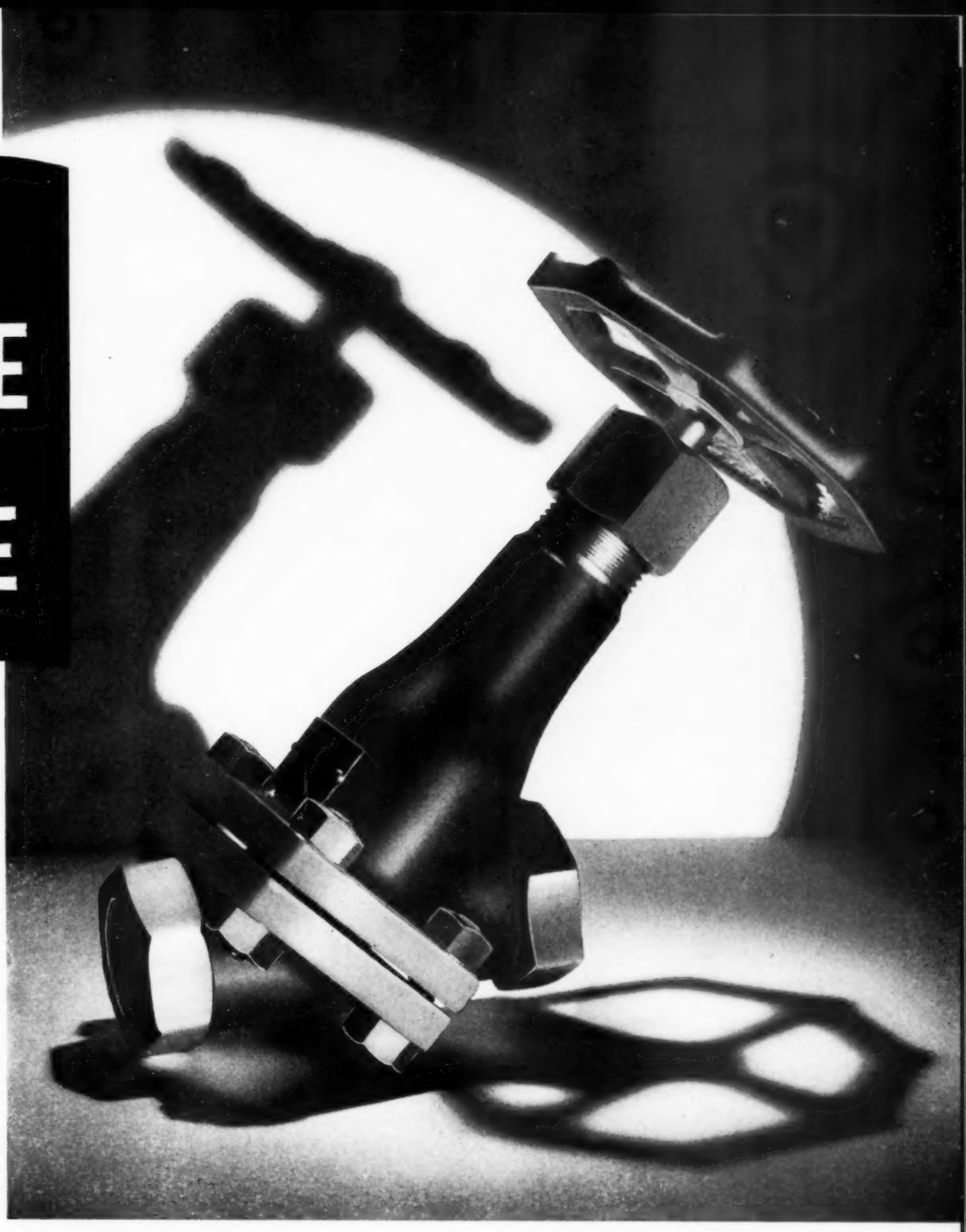
The distribution rack above the transformers behind the generating plant provides flexibility for outgoing loads. In addition to the two 600-kva. step-up transformers supplying the 16,500-volt current there are four small transformers for auxiliary purposes. Three of these are 25-kva. transformers stepping down the 2400-volt current to 440 volts to supply power to the fan motors of the water-cooling system and for operating a compressor used for air-starting of the engines. Three compressed air storage tanks supplied by this compressor are set in the transformer enclosure. Another small transformer of 10 kva. supplies 120-volt current for station lighting.

Placed within the plant building is



Generating units

Get This VALVE *on The* LINE



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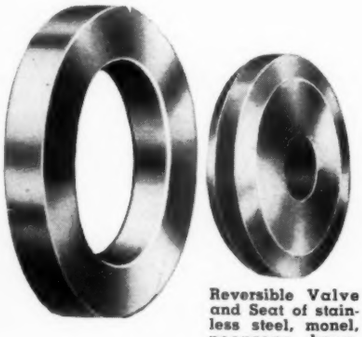

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This valve is made in screw or flange type, 1", 2" and 4" sizes, and the 180° type, as pictured, can be changed to 90° type merely by a half-turn of the base. The same valve and seat will fit any of the various valves of the same size, whether screwed or flanged.

It's standard line valve equipment with many major operators. It's the best buy on the market in line valves.

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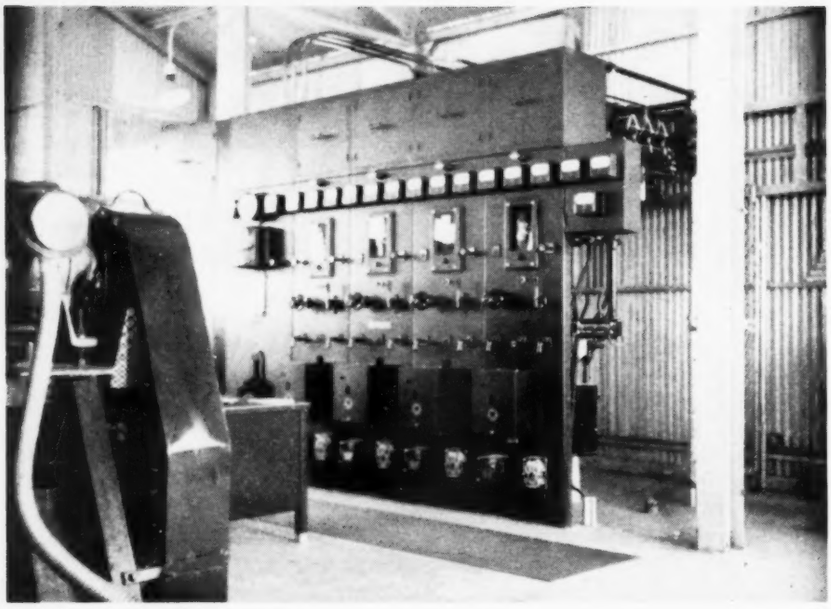


The switchboard has been placed conveniently in front of the two center units

an auxiliary gas-engine-driven unit that provides current for lighting in an emergency and for operating the air compressor for engine starting. All contingencies are provided for.

Cooling System

Of particular interest is the cooling system, which regulates the temperature of prime mover cooling through thermostat control. This system, as shown in the accompanying illustrations, consists of six cooler units, each of which is comprised of a radiator, a fan and a motor to drive the fan. The system is entirely automatic and was designed and installed by CCMO. Control is provided by regulation of the cooling air passing through the radiators as governed by fan speed, and no shutters, valves, or any manually-operated devices are employed.

The fan of each unit is direct-connected to a 15-hp., 2-speed gear motor. The temperature of the engines is maintained at 145 to 165° F. The fans automatically go on and off and from low to high speed or from high to low speed as the temperature of the cooling water tends to rise or fall. This control is procured by individual thermostats controlling each cooling unit, 12 thermostats being mounted in a case placed upstream from the first cooling unit and connected to the main stream of hot water from the engines.

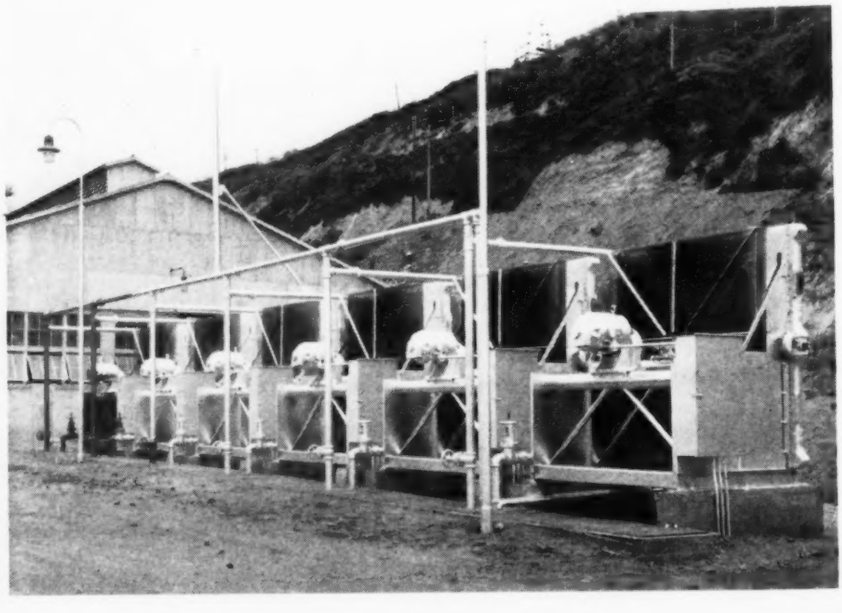
The units are numbered from 1 to 6. When the water in the circulating system, which is manifolded to the radiators, reaches 130° F. the fan of No. 1 unit starts at low speed. With each 4° rise in temperature another fan starts at low speed until all six are rotating. With further increase in temperature the No. 1 fan goes from low to high speed and with additional increases the succeeding fans go from low to high speed. Under average summer weather conditions in the middle of the day the cooling system is able to keep the engines at the desired temperature with the No. 1 fan running at high speed and the other fans at low speed.

Considerable power is conserved by this method of cooling. The motors running at low speed require 4.5 hp. and at high speed 12.5 hp. Lights on the switchboard panel show which fans are running and whether they are in high or low speed. A two-pen temperature recorder on the panel records the temperature of the hot water discharged from the engines to the cooling system and that of the cool water to the engines after cooling.

The electric generating plant took over the full load of all operations on the CCMO leases at Rincon on July 24, 1941, but had been taking over the load gradually during the previous few days. The plant will be fenced completely and the grounds beautified. Provisions have been made for the installation of more units should future operations make it necessary. Present wells are between 3000 and 9000 ft. deep, but there are possibilities of deeper production that, when later developed, may make increased capacity necessary.

Plan Compressor Plant

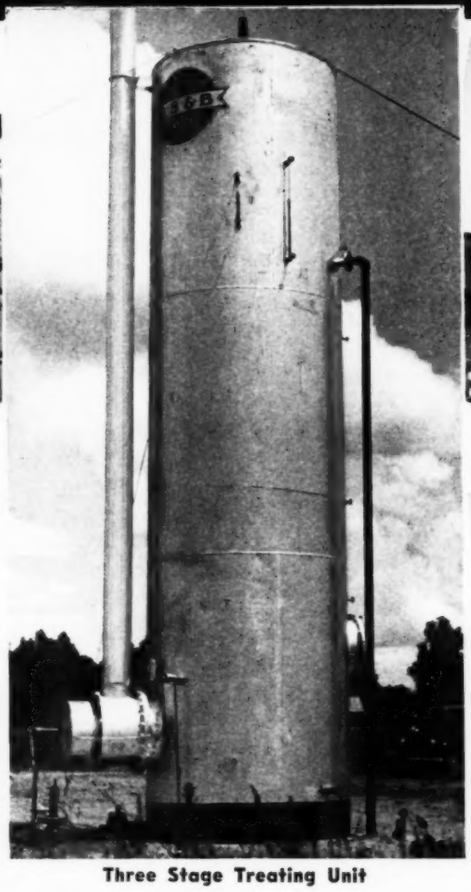
A compressor plant is shortly to be constructed adjacent to the electric generating plant and material and equipment have already been ordered for this purpose. This is a further conservation measure and the new plant will be operated by the same personnel as the generating plant. Some of the compressors to be installed will be electric-motor driven and others will be gas-engine driven. The gas will enter the compressor station at 35 lb. per sq. in. and normally will be boosted to 400 lb. per sq. in., although it can be compressed to 2000 lb. per sq. in. if necessary. After completion of the compressor plant a gas-lift system will be installed throughout the field.



The cooling system consists of six radiators with motor-driven fans

B S & B
EMULSION TREATING EQUIPMENT

Horizontal Firetube Heater

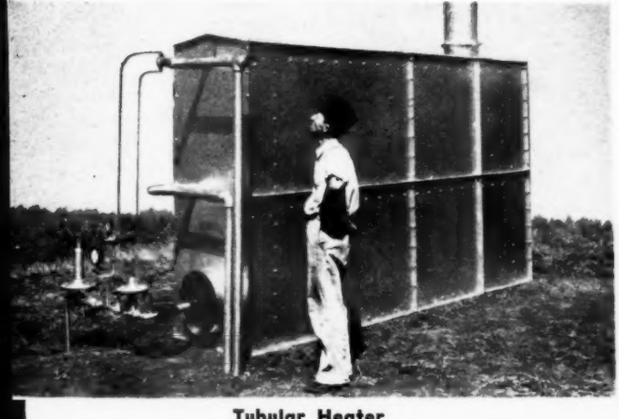


Three Stage Treating Unit

Indirect Heater

Vertical Firetube Heater

Volume Type Heater



Tubular Heater

Two Unit Treating System

P 772.421

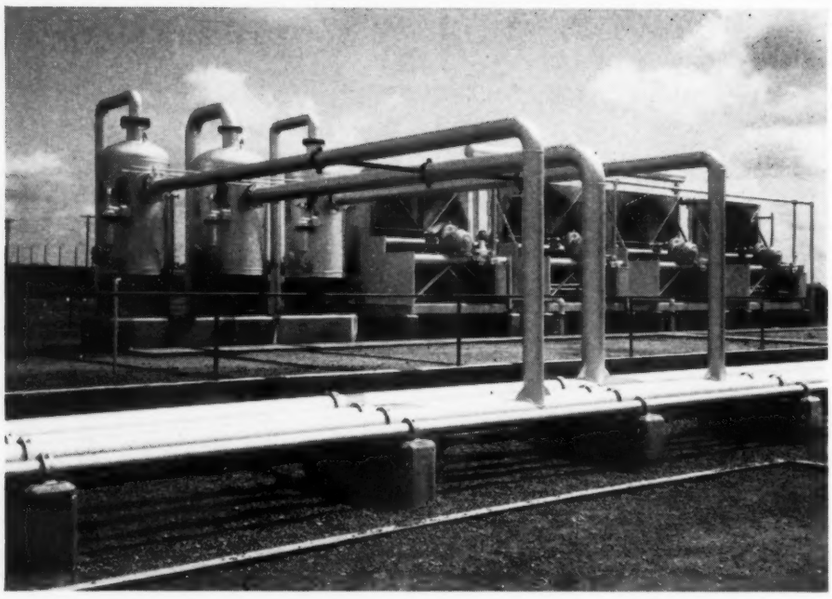


Fig. 1. Scrubbers, headers, and coolers, Driscoll plant

Petroleum Exclusive

by
E. O. Bennett
Chief Petroleum Engineer,
Continental Oil Company

Air-Cooling in Pressure Maintenance Plants

☆ Maximum efficiency and low maintenance cost are features of cooling units installed in South Texas plant

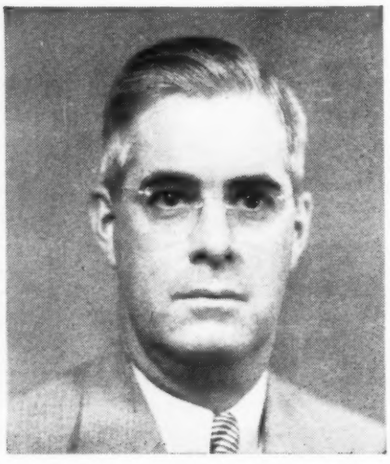
DURING the last few years gas-engine-driven compressors in excess of 100,000 horsepower have been installed in the United States for the purpose of returning gas to underground formations in connection with condensate recovery or pressure maintenance operations.

Climatic conditions at installation locations range from dry arid zones where water is extremely scarce to the damp humid atmosphere along the Gulf Coast where ample supplies of water are available.

Atmospheric Cooling

Good clean water, free from sediment and chemicals that will deposit in engine jackets under normal operating temperatures, is absolutely essential for continuous trouble-free operation of large gas engines. In some locations where compressor plants have been built during the last two or three years there is no water available. Some of these locations are in hot dry areas in which the normal midsummer temperatures rise above 100°F. and the humidity is very low.

Evaporative type coolers work well at such locations and do an efficient job of jacket cooling; but losses due to windage and evaporation may make their use uneconomical, and a system in which water losses are minimum must be used. Such a system naturally suggests that the jacket water be circulated in a closed system and that atmosphere be used to remove heat from the closed system. In its simplest form this is known as radiator cooling.



E. O. BENNETT

graduated from Stanford University in 1917 and the same year became associated with the Standard Oil Company of California—Was technical advisor for the U. S. National Advisory Committee for Aeronautics from 1918 to 1919—Returned to Standard Oil Company of California in 1919—Was petroleum technologist for the U. S. Bureau of Mines from 1924 to 1926—Chief petroleum engineer for Marland Oil Company from 1926 to 1928—Since 1928 has been with Continental Oil Company as chief engineer, assistant manager of drilling and production, and, currently, chief petroleum engineer.

Fig. 1 shows an installation of atmospheric coolers at the Continental Driscoll Ranch pressure maintenance plant. Three coolers are connected in parallel between intake and discharge headers and serve to cool the engine and compressor jacket water from two 400-hp. direct-connected gas-engine-driven compressor units. Since this picture was taken the cooling capacity has been increased to handle the cooling of an additional 600-hp. unit.

Additional Features

An unusual feature of these cooling units is that the engine lubricating oil as well as the jacket water is cooled by the same propeller fan in each unit. The air is pushed by the fan through a water-cooling section 8 ft. by 8 ft. and about 3 in. thick. Immediately in front of the water-cooling section there is an 8-ft. by 8-ft. by 1½-in. section for the engine lubricating oil.

The engine jacket water circulates through a closed system and the water is treated for corrosion with an inhibitor. These units have now been running for two years and the jackets

LET HAPPY GIVE HEAT THE AIR FOR YOU

Rear view of battery of HAPPY Cooling Units at Continental Oil Company plant at Benavides, Texas.

Driscol Plant of the Continental Oil Company near Benavides, Texas.

Let HAPPY Airfin Cooling Equipment solve your cooling problems. Engine and compressor jacket water cooling — lubricating oil, natural gas and compressed air cooling — steam and hydro carbon vapor condensing — all are handled the modern, efficient, economical way by this new cooling system.

Using a minimum amount of water, these HAPPY units allow exact temperature control, eliminate scale from engine and compressor jackets and give better engine performance and lower maintenance costs — just a few of the many reasons why more and more operators are swinging to HAPPY Airfin Cooling Equipment.

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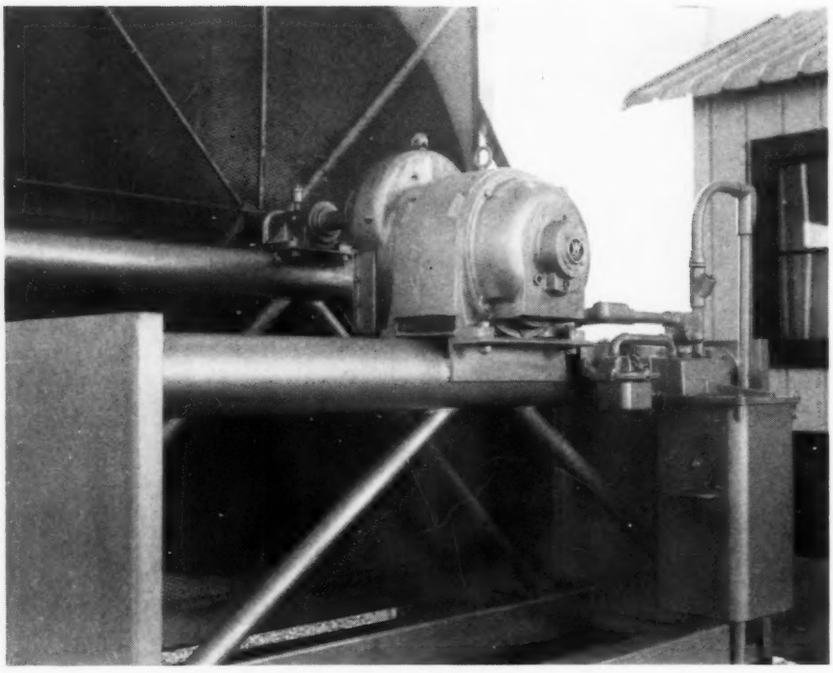


Fig. 2. Close-up of motor and starter installations; fan is rotating

have been entirely free of scale or corrosion. The 800-hp. cooling sections require less than 1 gal. per week of make-up water and have satisfactorily handled the cooling in the hottest weather yet encountered.

The engine-cooling sections are designed to handle the cooling with a temperature rise not to exceed 150°F. between inlet and outlet water.

The fans used for forcing air through the radiator section are multi-bladed and are direct-connected to a geared type induction motor. The motor mounting and starting equipment are shown in Fig. 2. Rigid mounting is very necessary in this type unit. As the cooling equipment is used in connection with the handling of gas, complete explosion-proof motor control equipment is installed in the interest of safety.

Air-Cooling Gas

In areas where there is a shortage of water for engine cooling the reduction of temperature between stages of the gas being pumped adds to the problem.

Air-cooling of gas through finned coil heat exchangers has been used but little in oil field compressor plants. The installation at the above plant consists of an 8-ft. by 8-ft. section cooled with a multi-blade fan similar to the water-cooling section. The cooling unit at the left side of the water coolers is used for cooling compressed gas. It is made up of two sections, one for cooling gas between the low and the intermediate stage and one for cooling between the intermediate and the high stage. In the direction of air flow the unit consists of eight rows of tubes with fins. At the lower left are headers for incoming and outgoing first-stage gas; at the upper right are headers for the second-stage compression. The gas-cooling sections have operated very successfully and cool the gas within the designed range.

Obtaining Maximum Efficiency

The location and position of radiator type coolers is very important. Strong winds blowing against the discharge side of the coolers cut their efficiency very materially. In order to maintain the cooling efficiency, reversing motors may be used to reverse the air flow when strong winds are blowing.

Fig. 3 is a general view of the Driscoll pressure maintenance plant.

It is suggested that manufacturers of cooling equipment of large horsepower give consideration to a design that will operate with constant efficiency regardless of wind direction or velocity. This may be done either with a shrouded design and vertical discharge or with fans running in horizontal planes.

Horsepower requirements for fan coolers are not large, and the total expense of air-cooling equipment compares favorably with efficient cooling towers.

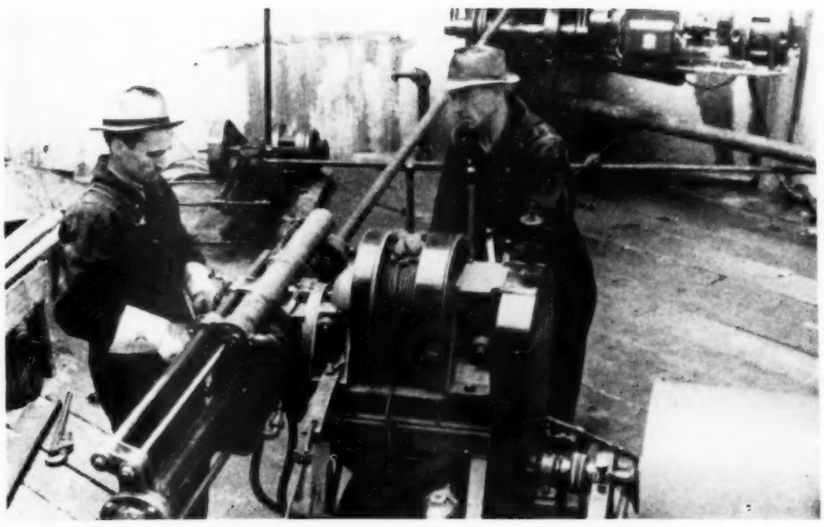
Experience indicates that the operation of engine jackets at somewhat high temperature with a small temperature differential gives best results. Air-cooled sections fit very well into this design.

In climates where there is an extreme variation in temperature, a variable-speed motor is advantageous for controlling temperatures.

Appearance and Maintenance

In appearance the air-cooled oil, water, and gas sections are neat and compact. They may be used wherever towers are used and in many places where towers cannot be used. The water consumption with air-cooled sections is practically zero. The sections are easily installed and can be readily removed if plant capacity is reduced. The maintenance of properly designed air-cooled sections is very low. Widespread general use is predicted for this type of cooling equipment.

General view of Driscoll plant. Individual cooler for generator engine may be seen at lower right



Equipment used for drilling horizontal wells

by Leo Ranney

Petroleum Engineer

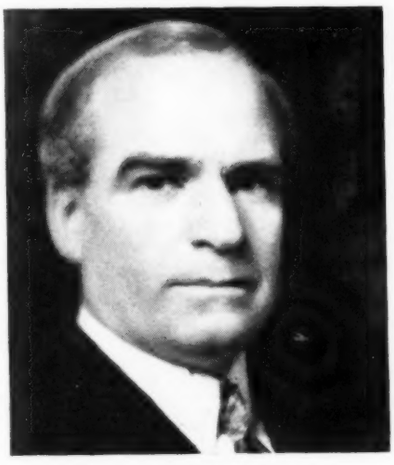
Horizontal Wells Are All in Pay—and Flow by Gravity[1]

☆ Technique of drilling and operating horizontal wells as secondary recovery method for shallow fields

OIL men have always been dreamers. Without their dreams and visions there would be no oil industry today. For 80 years some of their dreams have been: no dry holes; no hundreds of thousands of feet of barren rock to drill through, to reach 10 or 20 ft. of pay; wells that extend laterally for thousands of feet, always in oil sand; wells that flow after the field pressure is gone; recovery of 65 to 80 percent of the oil content of the sand, instead of 15 or 20 percent; the elimination of derricks and field powers; no shackle or sucker rods; no casing or tubing; no pulling or cleaning jobs after the wells are completed; nothing in an oil well to be replaced or repaired; one man-size pump that will pump a thousand acres of production; one man instead of ten to operate a whole section of land.

These dreams, with many others, have come true—and are handed to you in one basket, all combined in one development. Obviously, this development is not to be applied to wildcat operations or to oil sands 5000 ft. deep. But for secondary recovery in hundreds of shallower developed and depleted fields, where considerable quantities of residual oil are known to exist, the feasibility and practice of drilling and operating horizontal wells are brought to your attention.

The vital point of such a development is and always has been absolute control of the drilling bit, and the ability to turn the well up or down at will. In drilling some 7500 ft. of horizontal oil wells, always under control, it is believed that the technique has been fairly well mastered. In fact, turning a hole to follow a predetermined course presents no greater difficulty at 3000 ft. than at 100 ft. from the mouth—no whipstocks are used. A surveying instrument has been developed, integral with the core barrel, that automatically surveys the hole whenever a core is taken.



LEO RANNEY

graduated from Iowa State Teachers College in 1905 and from Northwestern University in 1911—Is the inventor of processes for mining oil from depleted fields, for commercial recovery of natural gas (firedamp) from coal seams, for producing ground water, and for the creation of underground gas reservoirs, to mention but a few of his accomplishments—Maintains offices at Columbus, Ohio, and Morro Bay, California — The methods described in this article are covered by numerous patent applications.

Drilling Horizontally from Shaft

In an experiment conducted in southeastern Ohio; 6 wells were drilled horizontally from a shaft in the First Cow Run Sandstone. These 3-in. wells were drilled in opposite pairs, half of them to property lines. While a 50-ft. core was being pulled from one well, the drill rods (and duplicate tools) were being run into the opposite well. This was accomplished by a new machine, known as the "rod puller," which moves the rods at the rate of 100 ft. per minute. The drill rods, in 10-ft. lengths, were not disconnected until both wells were completed. In deep holes this cuts drilling time at least 75 percent.

In all the drilling operation the tools were never stuck or frozen; the holes were surveyed every 50 ft. and corrected when necessary; there were no fishing jobs; two men operated the drilling machine, with 20 hp.; during all the experimental period, including stops and shutdowns for supplies, the average rate of drilling was 55 ft. per 7-hr. shift; when tools and supplies

[1]Paper read before the Illinois-Indiana Petroleum Association.

were on hand, often more than 100 ft. of hole was drilled per shift. To the south the bottom of the sand was level and the holes were flat, but to the north the sand was wavy, and the holes followed the waves. The mixture of oil and return drill water passed through a separator; the oil was saved in a closed tank, then pumped to the surface. During the entire experiment no man suffered even a minor accident; tests by a methane detector in the center of the work chamber never showed more than 0.1 percent gas; ventilation was by a blower at the surface and an 8-in. suction pipe. The cost of drilling, including experimentation, was 90 cents per ft. of hole; 100 ft. of light 3½-in. casing was grouted in each well.

From a study of 1½ miles of horizontal cores, we are convinced that an oil sand contains much more oil than usual core analyses indicate. Also, it is apparent, at least in the First Cow Run Sand, that because of lateral irregularities in texture, many pools of oil are trapped against recovery by vertical wells. The only method that occurs to us of reaching this trapped oil is by drilling horizontal wells through these isolated small pools.

Vertical wells in the First Cow Run Sand are not supposed to produce commercially until after being shot. As a test, No. 1 horizontal well from the shaft bottom was allowed to flow by gravity. After it had filled 400 bbl. of storage, it was producing 5 bbl. of oil per day, in spite of a saturation of only 15 percent (Fettke analysis), and a rock pressure of only 20 oz.

Horizontal Shooting

The greatest surprise in connection with the Ohio operation was the effect of the horizontal shot in the outcrop well. Although new results were expected, the observed effects were hardly believed to be possible. Sedimentary deposits are often laid down like leaves in a book, and sand grains lie with the flattest side down, their axes being parallel with the bed. In the vertical shooting, the rock must be torn apart, against the grain—in horizontal shooting the major breaks are "with the grain." Bedding planes are opened up above and at the sides of the shot, and resulting stresses shatter the rock above and on both sides of the well. Seismographic measurements indicated that the earth above the shot (250 ft. of rock overburden) was lifted 1½ in., which undoubtedly cracked the oil rock vertically with many cracks clear across the sand bed.

Long horizontal shots stem themselves. When the length of the shot is 5,000 to 10,000 times the diameter, the first 100 ft. exerts a tremendous pressure (and stem) against the rest. And the longer the shot, the greater the accumulation of pressure, the more effective the shot—and the more effectively the well clears itself. Because of the enormous cumulative pressure, exerted parallel to the bedding planes, and the advancing nature of the explosion, it is doubtful whether a horizontally shot well will ever be bridged over by the shot.

In following the radial pattern to develop the entire property, it became necessary to close-in the outcrop well and drill two radial horizontal wells through the shot area. It was then that the full lateral effect of the explosion was discovered. All circulation water was lost 45 ft. from the shot well—on both sides. For 40 ft. on each side, core recovery was only 25 percent, and the core was in short biscuits—instead of the usual 30- to 50-ft. lengths that represented 100 percent core recovery. As this happened in both transverse holes, it may be assumed that the rock was shattered laterally and vertically for a width of 75 to 80 ft. All this with a shot only 2¼-in. in diameter.

Examining bedding planes of formations exposed in wall of work chamber (before being lined with concrete)

Showing the hook-up in the work chamber for pumping horizontal wells. The flow line is a header connected to the casing. Flow is by gravity to the reciprocating pump, which pumps the fluid to the separator tank on the surface

Sanding-Up

In vertical wells, any sand, sediment, or paraffin that occurs must fall to the bottom of the well and pile up against the sand face, to retard the flow of oil; but in a horizontal well most of the loose material and paraffin are carried out by the stream, and that which is not, simply lies along the side of the hole, with practically no effect on production. To date, no piece of rock larger than a pinhead has been discovered in the shot hole, and the tools run freely to the far end.

Length of Wells

Insofar as controlling the elevation and direction of the horizontal hole is concerned, this may be done easily at any depth. The limit of possible length may be determined by the strength of the drilling machine. Forty hp. is sufficient for 2500-ft. lengths. At present, in an average oil sand, the practical limit may be considered as 3000 to 3500 ft.; in a coal seam (to degasify the coal) where friction is much less, a length of 5000 ft. would not offer difficulties. If the wells are from

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3000 to 3500 ft. long, from 800 to 1000 acres may be worked from one shaft. Twenty-four to 30 of such wells would expose from 72,000 to 105,000 ft. of producing sand—the equivalent of 3000 to 5000 vertical wells in a sand 20 ft. thick—something heretofore unheard of or undreamed of in the business of producing oil. Of course only experience will indicate the number and length of wells most profitable to drill in one operation.

Warming Up the Oil

When a vacuum of 22 points was pulled on the old outcrop well (after it had been shot), the temperature of the oil produced dropped from 53°F. (earth temperature there) to 46°F. Obviously, this must also occur when a high vacuum is pulled on vertical wells. Such an effect not only increases the viscosity and reduces the gravity of the oil, but hastens the deposition of paraffin.

One experiment recommended for further trial is the injection of hot gas at the sand face—in the mouth of a horizontal well. Previous attempts to apply heat to a producing sand have failed, partly because of barren rock that must be heated up before heat reaches the oil sand. In the old outcrop well, hot gas was injected under 10-lb. pressure for 7 hr., and then the well was closed. The next day the first gas recovered from the well had a temperature of 81°F. The well was produced daily—until at the end of the week the oil recovered still had a temperature of 57°F. In a shaft operation, after alternate wells have been converted to pressure wells, the pressure medium could easily be warmed before injection. Because of the great exposure of sand, it is probable that a pressure of about 30 lb. per sq. in. would suffice, but of course more experience is needed.

The Shaft

In Pennsylvania grade fields, engineers believe that shafts for horizontal wells may profitably be sunk to depths of 2000 ft., but there are many suitable fields available less than 1000 ft. deep. On work now under consideration, turnkey bids have been made at $55 to $75 per linear ft. for shafts 400 ft. deep, 8 ft. in diameter in the clear (or 8 ft. by 10 ft. rectangular) lined with concrete 1 ft. thick. The circular work chamber in the sand is also lined and floored with concrete. Bids for excavating the chamber approximate $5 per cu. yd.; placing the concrete costs $25 to $35 per yard. Pipes cast in the concrete shaft walls serve as conduits for air, gas, oil, water, electrical cables, and wires.

Costs

Assuming a depth of 400 ft., the cost estimate of the shaft is about $25,000; work chamber, hoist, cage, fans, and pump, $15,000; drilling rig, tools, and other equipment, $15,000. Thus the bare cost of getting ready to drill is $55,000. Add 10 percent, and if the area to be worked is 800 acres, this predrilling cost is less than $80 per acre. For the moment assume that drilling will cost $1 per ft.; then the first pair of 3000-ft. wells would cost $6000. Total cost of shaft, equipment, and two wells, $66,500. In round figures, say $75,000, which includes $13,500 for emergencies, engineering, and overhead.

Oil flowing from 3-in. casing of a horizontal well. Core analyses had shown a sand saturation of only 15 percent at this location

If physical conditions have recommended the location, it may be expected that each 100 ft. of hole will produce $\frac{1}{18}$ bbl. of oil per hr., or 1½ bbl. per day. This amounts to 90 bbl. daily for the two wells. This estimate assumes that the rock pressure is 20 oz. —if it is more than 2 lb. per sq. in., a larger production might be expected. With oil at present prices, production should pay for complete development of the property. Total capital advanced should be well under $100,000.

The cost of pumping fluid from the shaft will be less than 1 cent per bbl. From a property worthy of development in this fashion, a recovery of 5000 to 8000 bbl. per acre should be expected. It would be difficult to foresee an overall development and production cost as high as 50 cents per bbl., even in the thin and tight sands of the eastern fields. If labor is to be a problem in the future, it should be borne in mind that the operation of horizontal wells requires about one-fourth the number of men necessary to operate the same property when produced by vertical wells.

Degasification of Coal

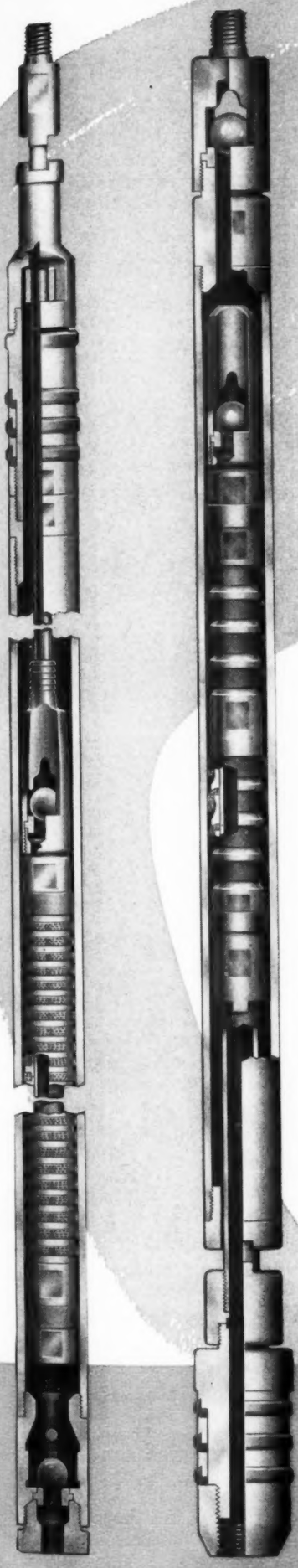
The fire damp in coal mines is only natural gas (methane) with a heat value of approximately 1000 B.t.u. This gas is held in the coal body itself by intermolecular sorption—in a very unstable equilibrium. It may be released and recovered by a partial vacuum, which may be applied to the virgin coal through long horizontal holes into the seam—from used or unused mine workings. Some coals in Ohio, Pennsylvania, and West Virginia contain as much as 300 to 2000 cu. ft. of free, sorbed methane per ton of coal in place. One seam is known to contain 22,000,000 cu. ft. per acre, most of which can be recovered for less than one-fourth the cost of piping gas from Texas. The coal mines of this country are now wasting in the air of ventilation about 500 million cu. ft. of methane gas each 24 hours. In the degasification of unmined coal, three important results are attainable: a profit on the gas recovered, reduced ventilating costs in future mining operations, and greatly reduced hazards to miners.

Horizontal Water Wells

The widest application of the horizontal well idea is now being made in the production of ground water from beds of sand and gravel. Approximately 15,000 ft. of 8-in. horizontal water wells have been installed, one installation alone having produced 15 million gal. of water daily for the last 4 years. The underlying principle is always the same—the exposure of the largest possible area of producing formation.

Conclusion

The subject of drilling and operating horizontal wells is so new and so broad that in this article it has been possible to touch upon only a few of the highlights. A geologic treatise on the revelations of the horizontal cores taken would fill a volume. The explosives engineer could write a book on the effects of horizontal shots. The production engineer would find one volume too small to cover producing and repressuring horizontal wells. If this development is to follow the precedent set by vertical drilling, new books will be required every few years—and past experience may be only the beginning of an entirely new technique in the business of producing oil.



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LATEST CONSTRUCTION Hardened and Polished barrels on these new pumps are the oustanding development and will measure up to the high quality standards of the Fluid Packed line. Although wider tolerances are allowed by the industry in the barrels of these pumps, over the metal-to-metal types, Flupaco Barrels will be found to require no more than 50% of tolerances allowed for cup and ring types. Plungers on these pumps also have important construction features. The "Flu-Ring" incorporates special Flupaco-made composition rings, spaced on the plunger by metal spacers which shoulder together as *one rigid unit*. Because the composition rings expand slightly and seal against the pump barrel, the "Flu-Ring" has proved highly efficient where water volume is a problem.
The "Flu-Cup" Pump is similar to the "Flu-Ring" in construction and operation, but has *cups* which expand under fluid pressure, sealing against the wall of the barrel.

SMOOTH PERFORMANCE All machined parts in both pumps are *centerless ground* then filed, gauged and completely protected against rust caused by handling. With these new lower-priced pumps, expert workmanship, perfect plunger fit and true barrel alignment insure smooth performance, less down-time, *less maintenance.*

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LAUGH WITH BARNEY

A cub reporter frequently reprimanded for relating too many details and warned to be brief, sent in the following:

Last night Sir Dwight Hopeless, a guest at Lady Panmore's ball, complained of feeling ill, took a drink, his hat, his coat, his departure, no notice of his friends, a taxi, a pistol from his pocket, and finally his life. Nice chap. Regrets.

If all the girls in the world that didn't neck were gathered in one room, what would we do with her?

Discipline

A slightly inebriated man finally found the keyhole and stamped into the house, where he stumbled around looking for the lights.

Voice from upstairs: "That you, Henry?" No answer. A big crash of glass. "Henry! What in the world are you doing?

"Teaching your goldfish not to bark at me!"

"I guess I'll cut in on this dance," said the surgeon, as he chloroformed the St. Vitus patient.

They laughed when I came in with shorts on, but when I sat down they split.

Airman (after landing in a tree): I was trying to make a new record.

Farmer: You did. You're the first man to climb down that tree before climbing up it.

Everything was in readiness for the marriage ceremony, and both groom and best man had arrived at the church in plenty of time. The former, however, was uneasy.

"What's worryin' ye, Tamson?" asked the best man, tiptoeing up the aisle. "Ha'e ye lost the ring?"

The other gazed at his friend's immaculate attire and general air of gay bachelordom. Then he heaved a woeful sigh.

"Na," he answered rather despondently; "the ring's safe enough, man, but I've lost ma wild enthusiasm."

Two men were discussing the poverty of the grass crop due to the dry weather.

"Mine was so short it was hardly worth cutting," said one.

"Short!" said the other. "Did you see mine? I had to lather it to mow it."

We know a girl who went with a writer—and he got some novel ideas.

Divorce is a hash made up of domestic scraps.

A very particular housekeeper was having her bedroom painted. Wishing to learn what progress the painter was making she crept to the bottom of the stairs and listened. Not a sound reached her ears.

She: Painter, are you working?

Painter: Yes, ma'am.

She: I can't hear you making a sound.

Painter: Perhaps not, ma'am; I ain't putting the paint on with a hammer.

Mother: Quiet, dear, the sandman is coming.

Modern Child: O.K., Mom, I won't tell Pop.

"Now, Bobby," the teacher said, "tell me where the elephant is found."

The boy hesitated for a moment, then his face lit up.

"The elephant," he said, "is such a large animal it is scarcely ever lost."

Real Estate Salesman: Yes, sir, this building is absolutely without a flaw.

Southern Gentleman: My gawd, suh, what does yo' walk on?

Teacher: Were you copying his paper?

Student: No, sir, I was only looking to see if he had mine right.

Sergeant: Where is the balance of your rifle?

Rookie: This is all they gave me.

"Wish we had a fifth for bridge."

"You don't need a fifth for bridge, you dope."

"Make it a pint, then."

Salesman: I sell underthings to nudist colonies.

Farmer's Daughter: What kind of underthings do nudists need?

Salesman: Cushions.

"How's your companionate marriage coming on?"

"Not so good. I lost my wife's address."

Prof: The examination papers are in the hands of the printer. Now, are there any questions anyone has to ask?

Student: Who is the printer?

"I hear you and the leading lady are on the outs."

Electrician: "Yeah, it was one of those quick-change scenes with the stage all dark. She asked for her tights and I thought she said lights."

"I can let you have a cot in the ballroom," said the clerk, "but there is a lady in the opposite corner. If you don't make any noise she'll be none the wiser."

"Fine," said the tired man, and into the ballroom he went.

Five minutes later he came running out to the clerk.

"Say," he cried, "that woman in there is dead!"

"Sure," was the answer, "but how did you find out?"

A nice girl shouldn't hold a young man's hand.

A nice girl has to.

"Why, Maggie, ah thought yo'all was on youah honeymoon. Wasn't yo' married, honeychile?"

"Yes, ah was married all right, but Gawge wanted to go to Memphis and ah been there befo' so ah let mah sister go in mah place."

"Porter, get me another glass of ice water."

"Sorry, suh, but ef I takes any more ice, dat corpse in de baggage car ain't goin' to keep."

She: How do you like my new evening dress?

He: I can't tell until you get up from the table.

Overheard in London

"Duchess, in spite of the present European conflict, I think I'll remain over indefinitely. These blackouts are all right."

"You are an apt boy. Is your sister apt, too?"

"Yeah, if she gets the chance, she's apt to."

"I was out with a nurse last night."

"Well, cheer up, maybe your mother will let you go out without one next time."

Courtroom Scene

"Judge, I want a divorce. Her father didn't have any shells for that shotgun."

Then there is the story about the man who, on his first visit to the bank, was asked to indorse his check, and wrote:

"I heartily indorse this check."

HERE'S THE BUGABOO OF SUCCESSFUL CEMENT JOBS

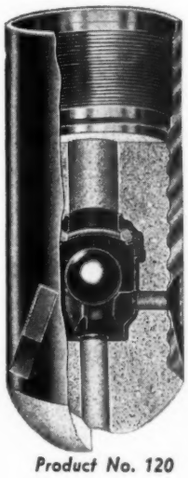
CHANNELING

. . . and you can't get rid of him by merely saying "scram." But you can reduce him to about this size by using Baker Cement Wash-Down Whirler Equipment. The definite downward as well as upward whirling action afforded by this equipment provides the best possible opportunity of a more nearly complete encasement of the pipe at the critical point, the shoe joint, with a uniform body of cement, thus reducing the hazard of channeling to a minimum.

The efficiency of Baker Cement Wash-Down Whirler Equipment, which was introduced and developed by Baker engineers, has been demonstrated in thousands of successful cement jobs. And it is generally acknowledged today as being the most efficient type of cementing unit available.

The Baker Wash-Down Whirler Principle is available in several types of units . . . a Baker Cement Wash-Down Whirler Float Shoe; a Baker Cement Wash-Down Whirler Guide Shoe; and a Baker Cement Float Collar in combination with either type of Whirler Shoe.

For detailed information, refer to page 222 of the 1941 Composite Catalog, or get in touch with your nearest Baker office or field representative.



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Quick FACTS Concerning BAKER CEMENT Wash-Down WHIRLER Float Shoe

It Provides . . .

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(5) Easy Drillability

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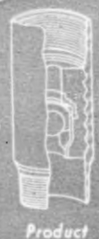

Baker Cement Float Shoe
Baker Cement Float Collar

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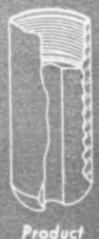

Baker Cement Guide Casing Shoe

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Baker Cement Wash-Down Whirler Float Shoe

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Baker Cement Wash-Down Whirler Guide Shoe

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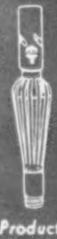


Baker Cement Whirler Float Collar with Solid Bottom Baffle with Metal "Petal" Basket

Product No. 306

Running Tour

WITH MEN IN THE INDUSTRY

R. C. STAMETS, one of the best-known oilfield equipment dealers in Oklahoma, died July 24 in a Tulsa, Oklahoma, hospital following an operation. Fifty-three years old, Stamets resided at 1389 East Twenty-sixth Street in Tulsa. He is survived by a brother, two sisters, two sons, and a daughter.

Business associates of Stamets reported that he had been in the supply business from 35 to 38 years, beginning with the National Tube Company in Pittsburgh, Pennsylvania, while still in his teens. He became associated with the Oil Well Supply Company in 1918 in Pittsburgh and went to Tulsa in 1930. He transferred to Dallas, Texas, when the main office was moved there and returned to Tulsa about four years ago.

PAUL GRIFFIN, vice-president and treasurer of the Oklahoma Pipe Line Company, Tulsa, Oklahoma, has been elected president of the company to succeed W. R. FINNEY, resigned. Finney transferred to New York headquarters of the parent company, the Standard Oil Company of New Jersey, in 1939. Important duties there made it advisable to relieve him as head of the pipe line company. BRUCE RAMSEY was elected vice-president by the directors to fill the vacancy left by Griffin, however, Griffin will continue to act as treasurer. Ramsey was a director and general superintendent of the company before his promotion.

O. C. MUELLER, of the B. F. Goodrich Company, has been transferred as sales representative from Cincinnati, Ohio, to Pittsburgh, Pennsylvania. He is succeeded at Cincinnati by A. C. LUTZ. J. M. COONEY is transferred from Cincinnati to Dayton, Ohio. B. E. SILVER, formerly with the manufacturers' sales department in Washington, joins the hose sales department at principal company headquarters in Akron, Ohio, and J. V. POWERS, sales correspondent in the New York district office, becomes field representative of the district with Albany headquarters.

L. A. TOONE, general manager of the Sarawak Oilfields, Ltd., in Miri, Sarawak, is now in the United States for a short business visit.

C. W. CHRISTENSEN, assistant general manager of sales of the Rubber Service Department of Monsanto Chemical Company, has been promoted to general manager of sales. JAMES F. HAND, Rubber Sales Service Department, succeeds Christensen. DR. CAMPBELL ROGERS MCCULLOUGH, research staff of the phosphate division of Monsanto, has been transferred to the central research department. Formerly located in Anniston, Alabama, McCullough's new location will be Dayton, Ohio.

HARVEY W. GILBERT, Harvey W. Gilbert Petroleum Company, left recently on a tour to inspect Permian Basin and East Texas interests of his company and then continued to Washington, D. C., in the interest of a new airport in his capacity as chairman of the Beaumont-Port Arthur, Texas, Industrial Commission.

GORDON W. SWINNEY, former student at Kansas University, Lawrence, Kansas, has been employed as apprentice petroleum engineer by Phillips Petroleum Company, at Fairfax, Oklahoma.

SENOR PAUL ZUMELZU R, president of Yacimientos Petroliferos Fiscales Bolivianos, the Bolivian government oil company; IRA KING, his assistant and production superintendent, and DOUGALD MACDOUGALD, warehouse superintendent of the Mene Grande Oil Company at Cabimas, Venezuela, were guests of the Houston Chapter of Nomads at a recent luncheon at the Houston Club.

JOHN E. SERGEANT resigned from the Skelly Oil Company, Tulsa, Oklahoma, effective July 31, to accept a position in the civil engineering department of Magnolia Petroleum Company at Dallas, Texas.

FRANK J. GARDNER, staff geologist for Rinehart Oil News Company, Houston, Texas, has been awarded the Joseph S. Cullinan scholarship in petroleum geology founded by Will C. Hogg, former governor of Texas, in honor of Cullinan. The scholarship is the highest any college or university in Texas can present to a student in petroleum and is made every two years.

PAUL T. GRAFF has joined the staff of The Foxboro Company as a sales engineer, specializing in the promotion of the company's control instrumentation. He will be located at the company's main office in Foxboro, Mass.

FRANK BROWN, export representative, New York, New York, and Mrs. Brown, left La Guardia field by plane August 1 for South America. They will make their entire trip by plane and visit Colombia, Trinidad, and Venezuela, being gone about 60 days.

R. W. LESLIE is the new manager of refinery operations for Wasatch Oil Refining Company and the Idaho Refining Company, Salt Lake City and Pocatello, Idaho, respectively. Leslie was formerly with Skelly Oil Company, Eldorado, Kansas.

FRED E. COOPER, president, Fred E. Cooper Company, Tulsa, Oklahoma, is touring the California oil fields.

R. B. ALLPORT, Tulsa, Oklahoma, has been named manager of the Fort Worth, Texas, office of CHESTER IMES, Tulsa oil operator.

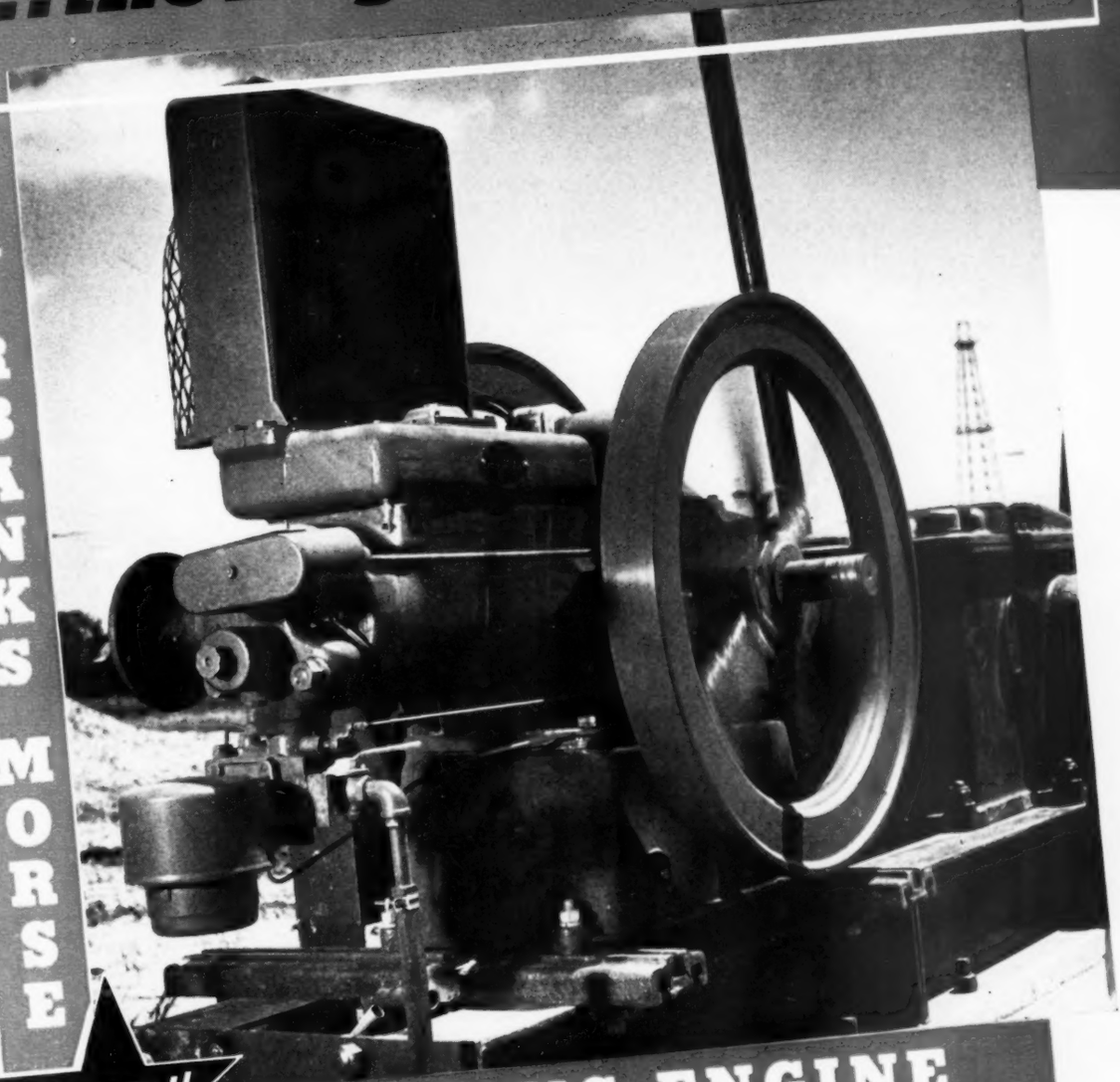
H. H. WEST, vice-president of the Mountain Fuel Supply Company, assistant secretary of the Rock River Petroleum Company and the Ohio-Mexico Oil Corporation, has been made assistant to the president of the Ohio Oil Company.

H. K. BROWNING has transferred his office from Tulsa to Oklahoma City, Oklahoma. He is division sales manager, Mid-Continent Division, for Kobe Incorporated.

DONALD D. WILLIAMSON, now district engineer of the Asphalt Institute, became consulting engineer August 1 for the Talco Asphalt and Refining Company of Mount Pleasant and Dallas, Texas. The announcement was made by CAPT. J. F. LUCEY, Talco president.

S. W. BREEDING, Dallas, Texas, oil broker, has been named director of the gas utilities divisions by the Texas Railroad Commission. CLINTON OWSLEY has been acting director of the division and has been transferred to director of production, accounting, and oil statistics. C. F. PETET, secretary of the commission, has been transferred to the post of inspector and operating service expert. TED READ, commission office employee, will fill the vacancy left by Petet. DAVE HENDERSON has been made acting chief valuation accountant in the gas utilities division and W. W. GIST of Winnsboro has been appointed senior accountant of the commission.

ONE OF OUR STAR SALESMEN
..the Engine on the Job



FAIRBANKS MORSE

"ZC" PUMPING ENGINE

You need only to see the FM "ZC" Pumping Engine on the job and talk to the owner to learn the efficient way it handles any pumping problem—at unbelievably low operating costs.

The smooth, steady power averaged by the *extra-heavy flywheels* levels off the cyclical load demand. The *automatic intake valve* safely limits power output. The *one-way breather* seals the crankcase and keeps oil clean.

These are a few of the things you will learn when you see the FM "ZC" Pumping Engine on the job. There are four sizes to meet your various requirements . . . each of them will give you the same service that brings satisfaction to your neighbor.

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"SERVING THE OIL AND GAS INDUSTRIES"

GEORGE B. EWING, JR., has joined the staff of sales engineers attached to the Houston, Texas, office of The Foxboro Company. Ewing has had wide industrial experience in the machine and tool-making industries and in petroleum refining operations.

M. J. WILLIAMS, Eastman Oil Well Surveying Company, has been transferred from the Oklahoma City, Oklahoma, Division office and appointed chief engineer of the Casper, Wyoming, office of the Rocky Mountain Division.

MILLIARD J. COFFEY was buried Tuesday, July 22, in San Antonio, Texas. A well-known oil operator of South Texas, Coffey had formerly been connected with MONTE WARNER, Dallas, Texas, oilman. He went to Texas in 1926 from his native state of Wyoming after serving as state oil and gas commissioner after his graduation from the University of Wyoming.

J. R. MCCHESNEY is now gas superintendent and stationed in the Tulsa, Oklahoma, office for the Pure Oil Company. He was formerly a foreman in the Nowata district for the company.

JOHN F. CAMP, South Texas oilman of San Antonio, started the movement "Oil for Britain", in which each oil producer in Texas donated one day's production to Britain. Camp put the plan into action by a personal gift of 5000 bbl.

ALBERT ROTHROCKE, superintendent of Colombian Petroleum Company at Barco, South America, and J. D. VANDERBERG, of Shell Oil Company, were guests of the Houston Chapter of Nomads at a luncheon at the Houston Club July 30.

DR. ROBERT E. WILSON, petroleum adviser to the Office of Production Management at Washington, D. C., resigned August 1. After a vacation he will resume his post as president of the Pan-American Refining Corporation, New York, New York. The position vacated by Dr. Wilson will be filled by DR. W. G. WHITMAN, professor of chemical engineering, Massachusetts Institute of Technology, who recently joined the staff of the petroleum adviser. Wilson has served since June 20, 1940.

R. C. ALDEN, director of research of Phillips Petroleum Company, Bartlesville, Oklahoma, was guest commentator at the monthly review of the oil news by oil writers of Tulsa, Oklahoma, over radio station KTUL this month.

ARTHUR V. BOURQUE has been in Tulsa preparing to move to Chicago to assume his duties as manager of the Tank Car Service Committee, created to direct the movement of tank cars under the national defense program. Bourque, formerly secretary-manager of the Western Petroleum Refiners Association, also was previously with the National Gasoline Association of America. G. E. EVERETT will be assistant to Bourque in the tank car office in Chicago. He was assistant secretary of W. P. R. A. and later was with the American Petroleum Institute.

C. M. BRYSON has resigned as superintendent of the Illinois division of the Toronto Pipe Line Company with office at Graysville, Illinois. Toronto is an affiliate of the British American Oil Producing Company.

W. C. WHALEY, vice-president of the Barnsdall Oil Company, was elected president of the California Petroleum Safety Board at its annual meeting. He succeeds L. A. CRANSON, vice-president of Honolulu Oil Corporation, who, although his term expired, will continue to serve the Safety Board as a vice-president. In addition to Cranson, L. L. AUBERT, Bankline Oil Company, and A. S. HAYES, Bell and Loffland Drilling Company, were elected at the same time. With Whaley, the three vice-presidents and the treasurer, R. W. METCALF, Signal Oil Company, constitute the board's executive committee.

BURDETTE BLUE resigned as president of Indian Territory Illuminating Oil Company when that company was taken over by Cities Service Oil Company. Blue has moved to Tulsa, Oklahoma, from Bartlesville and will engage in the general practice of law from the offices of the firm of Ramsey, Martin and Logan in the National Bank of Tulsa Building. He will not be a partner in the firm and will act in an advisory capacity to various Cities Service Oil Company interests in addition to conducting his general practice. Blue had been with I. T. I. O. for 25 years. He had been president since 1935. R. L. MORTON, I. T. I. O. vice-president, was elected a director and vice-president of Cities Service.

Other action taken by the board of directors of Cities Service included election of A. W. AMBROSE, director and vice-president of Cities Service, to executive vice-president; L. A. LYND was made a director and assistant treasurer; T. P. STEEPER, Cities Service, was elected a vice-president; M. A. WILSON, Cities Service, and E. B. EMENHISER, I. T. I. O., were named assistant secretaries of Cities Service.

J. COOKE WILSON, who has been in the oil business since 1901 in Beaumont, Texas, has been named general chairman for the Spindletop anniversary convention of the Texas Mid-Continent Oil and Gas Association, to be held at Beaumont October 9, 10 and 11. E. W. GILDART is vice-president and BRYAN MCADAMS, secretary. Subcommittee heads are W. C. TYRRELL, T. R. SHUMATE, JOHN W. NEWTON, W. W. LEACH, WALTER CASEY, SCOTT W. MYERS, CLARENCE DEBUSK and KARL D. SCHWARTZ. These chairmen will be members of the executive committee, which also will include GEORGE C. MORRIS, CHILTON O'BRIEN, F. P. DODGE, MIKE WELSH, and C. R. STEVENSON.

DORSEY HAGER and L. C. EWING, Centralia, Illinois, have taken over the Jarrell Process, patent number 2228629, for the processing of oil wells by the use of chemicals, for the state of Illinois under the name of KEM-I-KAL, LTD., of Illinois. Hager will have charge of engineering and Ewing of sales.

JULIAN B. WILLIS, formerly petroleum engineer with the Sinclair Refining Company, East Chicago, Indiana, has been drafted into the army and is now taking basic infantry training at 65th training base, Camp Wolters, Texas.

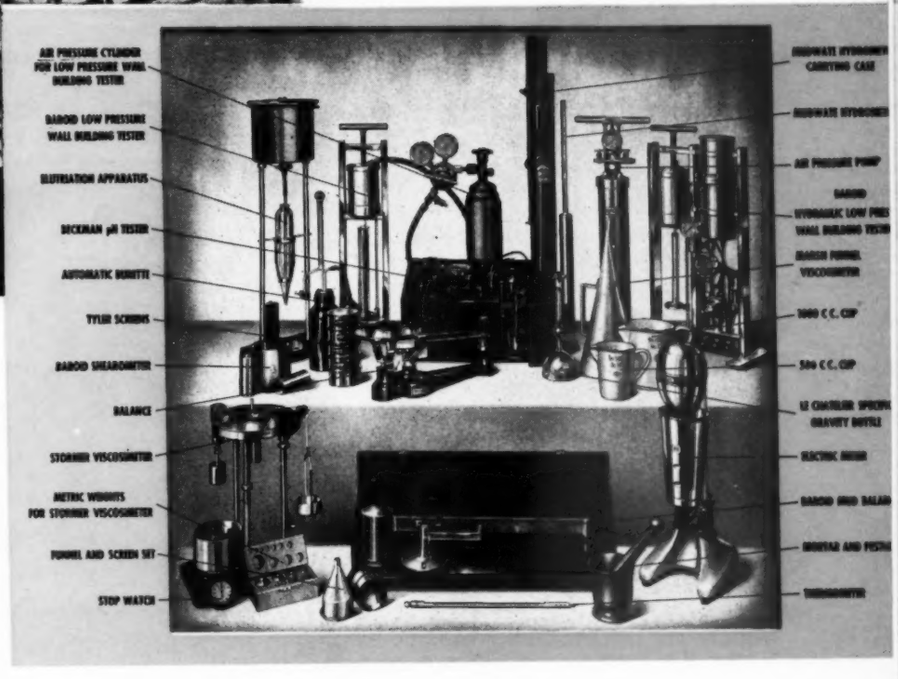
GAY CARROLL, Humble Oil and Refining Company comptroller, is the newly elected president of the recently chartered Houston, Texas, chapter of the Controllers' Institute of America. Others named to office include JOHN BRODERICK, Angelina Building Materials Company, Lufkin, Texas, and N. V. TRULY, comptroller of Humble Pipe Line Company, Houston, vice-presidents; H. W. BROWN, Kelly Manufacturing Company, Houston, secretary-treasurer.

ROBERT THOMAS HILL, 82, died July 27. He was one of the great figures in the geological profession. Hill worked out the fundamentals of Texas Cretaceous geology, and his work on antillean geology is still considered the best on that subject.

RUSSELL G. DAVIS has received appointment as manager of the commercial gear plant at 5301 South Western Boulevard, Chicago, Illinois, of Foote Bros. Gear and Machine Corporation. The announcement was made by W. A. BARR, president and general manager. Davis has a background of 20 years service with the Chain Belt Company of Milwaukee, Wisconsin.

These simple tests may prevent expensive drilling difficulties

THESE DETERMINATIONS ARE QUICKLY AND EASILY MADE WITH SIMPLIFIED BAROID MUD TESTING EQUIPMENT



Knowing the characteristics of the drilling mud enables the operator to make suitable changes if necessary or keep the mud in its present condition. Careful check must be kept of all the characteristics of the mud. This knowledge may prevent serious drilling difficulties.

Entrained gas will cause a lowering of the weight. If caught in time, a blowout may be prevented. Shale may thicken the mud unduly. More weight may be needed to hold back caving formations. Salt or salt water, gypsum or anhydrite drilled up by the bit, may cause a rise in pH with resulting flocculation of the mud. High water loss may cause caving of the hole. Too much sand or a thick mud cake may cause stuck tools and bit. Gel strength must be maintained at a suitable point to bring up cuttings, but not too high to drop them in the ditch.

These determinations are quickly and easily made with the simplified Baroid Mud Testing Equipment shown here. Full particulars and prices on request.

PATENT LICENSES, unrestricted as to sources of supply of materials but on royalty bases, will be granted to responsible oil companies and operators to practice the inventions of any and/or all of United States Patents Nos. 1,575,944; 1,575,945; 1,807,082 and 1,991,637 and further improvements thereof. Applications for such licenses should be made to the Los Angeles office.

BAROID SALES DIVISION

NATIONAL LEAD COMPANY

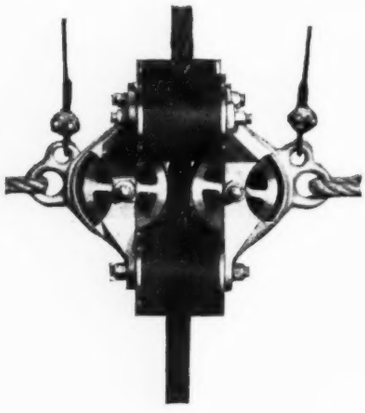
BAROID SALES OFFICES: HOUSTON • LOS ANGELES • TULSA

BAROID PRODUCTS: BAROID AND COLOX, AQUAGEL, FIBROTEX, BAROCO, STABILITE, AQUAGEL-CEMENT, SMENTOX, ZEOGEL, IMPERMEX, MICATEX, TESTING EQUIPMENT, BAROID WELL LOGGING SERVICE

MACHINERY and EQUIPMENT

Grizzly "No-Wip" Line Saver

SEVERAL improvements in the Grizzly "No-Wip" Line Saver recently have been announced by the manufacturer, E. M. Smith Company, 600-650 South Clarence Street, Los Angeles, California. All rubber rollers,



for example, now are made larger than previously, resulting in longer wear, it is stated. The cores of these rollers are now packed with grease, and are designed so that lubrication is automatic both to shafts and bearings; thus insuring complete freedom of the rollers and a free-spinning action at all times without necessitating further lubrication of any part of the device while in service. It is asserted that no lubrication, maintenance, or attention is required for months at a time.

The frame has been provided with extended "ears" and protective plates to prevent the rollers from coming in contact with other objects or rolling, when the device is lying around or being transported from one place to another. The frame also has been made heavier and stronger.

A new method of locking the rollers in position is provided by a cap that fits snugly over a boss that is an integral part of the frame and prevents the roller shaft from becoming disengaged even if the nut should become loose. This method also relieves the nut of any strain in holding the rollers in place.

The device is designed to eliminate whipping and excessive wear of wire lines in oil-field service. It forces the line to track perfectly, prevents piling up, simplifies spooling, and saves many miles of wire lines every year, it is stated. Those interested in further details are asked to send for Bulletin No. 10-OF.

Plomb Tool Company Announces Wheel About

PLOMB TOOL COMPANY announces the Wheel About, a mobile tool cabinet built on the principle of the "add-a-shelf" book case. It consists of the Wheel About roller cabinet, on top of which may be mounted, by bolts provided for this purpose, the master tool chest.

The assembly permits moving the complete tool set from job to job, or

removal of either the upper or lower tool chest complete for use on outside jobs.

The Wheel About cabinet, mounted on four easy-rolling casters, is large enough to carry a tote tray, has lock and key and door that lifts up and slides out of the way.

The master tool chest has four drawers operating on roller slides. The top lifts up, and has clips for holding speeders. Lock and key are identical with the lower unit. Both units are round cornered, painted Chinese red.

Specifications are as follows: Wheel About complete, overall cabinet measurements are 44 in. high by 27 in. wide by 17 in. deep; weight, 112 lb. Wheel About unit alone, cabinet measurements 22 in. high by 27 in. wide by 16 in. deep; weight, 37½ lb. Master tool chest alone, 20½ in. high by 27 in. wide by 12 in. deep; weight, 75 lb.

Wider Laminum Shim Stock Available

LARGER one-piece shims now can be cut from Laminum shim stock. Laminated Shim Company, Inc., Glenbrook, Connecticut, releases this announcement in connection with the new 7-in. usable width of laminated shim stock now in production.

Sheets of Laminum shim stock can be supplied to 7-in. by 36-in. dimensions in addition to the 6-in. by 36-in. sheets produced heretofore. Not only does the new width permit the company to manufacture larger jointless shims, but this new size shim stock affords the same convenience to purchasers of Laminum shim stock who cut their own shims, it is stated.

The new sheets are available in overall thickness from 0.006 to 0.125 in. All thicknesses may be obtained in all-laminated sheets with choice of 0.002- or 0.003-in. thick laminations; or various thicknesses may be had partly laminated and partly solid.

How one simple operation RENEWS PISTONS

at a fraction of new piston cost

★It costs a lot of hard cash to shut down a drilling rig—yet you have to do it every time your slush pump pistons need replacement. But if you want to save real money on slush pump expenses, there's an easy way to do it! Use the new improved MacClatchie Wear-Ever Pistons. For one simple operation right at the rig enables you to renew these long-life pistons at only a fraction of original cost! You save money, because you cut 'way down on original piston costs, and reduce maintenance costs and down time.

YOU START YOUR SAVINGS HERE

...with REPLACEABLE RUBBERS. No need to replace the body to completely renew Wear-Evers. Just have a spare set of rubbers handy. Pull off worn rubbers, put on new ones—using center spool and end plates over again. This easy operation puts Wear-Evers in new condition for another long run... but at a cost that's often less than half that of new pistons. That's true economy!

You Continue Saving Here

...with FULL PUMP PROTECTION. Besides the economies of Wear-Ever replaceable rubbers, you save on all-around pump maintenance with these MacClatchie features!

SOFT STEEL PROTECTORS that protect and prevent wear on center spool, thereby prolonging the life of the center spool for countless runs. **LONGER LINER LIFE**—The soft metal protectors on the rubbers also prevent the liner from coming in contact with any hard steel parts of the piston, thus also increasing the life of your liners.

You Complete Your Savings

...with LONGER WEARING LIFE. Operators drilling deep wells with high mud pressures are making as high as 20,000 feet of hole with a single set of Wear-Evers. That's because these pistons have been greatly improved in design and construction.

Make your next piston installation Wear-Evers. They'll outwear any others. Wear-Evers are available in all sizes from 2¾" to 9½" for all pumps and rod tapers, and in Resistal Rubbers that are recommended for pumping hot fluids, or for use where oil and gas conditions are present. Order a set today—or send for detailed literature describing these new pistons!

MacCLATCHIE MANUFACTURING CO.

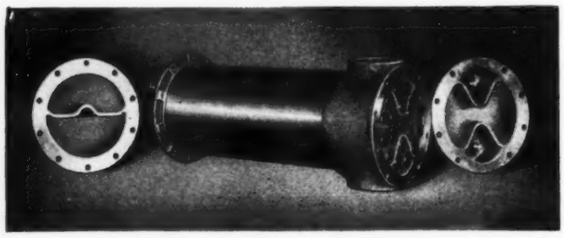
COMPTON, CALIFORNIA

Mid-Continent Distributor: HAKE TOOL COMPANY, Houston, Texas • Rocky Mountain Representative: C. E. "BUD" STRONG, Casper, Wyo. • Foreign: GEORGE R. WOODS, 17 Battery Place, New York City

Bettis Heat Exchangers

BETTIS heat exchangers are made entirely of copper and bronze and are so designed to have an unusual heat transfer for their size and price, according to a recent statement by the manufacturer. Type No. 800 exchanger weighing 80 lb. has a 500,000 B.t.u. transfer with exhaust steam at atmosphere.

Design incorporates all smooth surfaces with no return bends to trap scale deposit. Multiple pass circulation and bronze heads allow for maximum heat transfer. Added to this is the polished exterior acting as reflective insulation to prevent heat loss without the expense of insulation.



"Cleanability" is another feature of the Bettis heat exchanger. Bettis heat exchangers are distributed by Bettis Sales Company, Houston, Texas.

Otis Removable Pressure Lock Packer

A PRESSURE lock locking device and preset pressure seal packing elements are two new features used for the first time in a packer by Otis Pressure Control, Inc., Dallas, Texas.

The pressure lock locking device consists of only one set of slips; however, the construction is such that a pressure differential in either direction across the packer is utilized to further lock it in place. Consequently, the greater the pressure the more securely the slips "grip" the casing. The slip assembly has eight individual slips with a combined slip area much greater than that of the conventional packer, therefore, the lock is both positive and flexible. One of the most important features of this lock is that neither the weight of the tubing string nor a column of mud in the casing annulus is necessary to hold the packer against upward thrust; consequently, the packer cannot blow out of the hole nor can the tubing drop should the surface connections become damaged. Furthermore, the tubing is always in a freely suspended position. By far the most valuable feature of the lock is the ease with which it can be released. After the tubing has been pulled up a distance of about 3 ft. the bypass through the packer opens. Further upward movement of the tubing imparts a jar to the slip mandrel causing it to move out of the slips and permitting them to retract.

The preset pressure seal packing elements are made of oil-proof Neoprene molded and vulcanized to a steel connection ring and reinforced with a composition fabric cup. The O.D. of these elements in all cases is approximately $\frac{1}{16}$ in. larger than the I.D. of the casing in which they are run; however, they are designed so that the Neoprene can flow

For Engineered Performance

Use

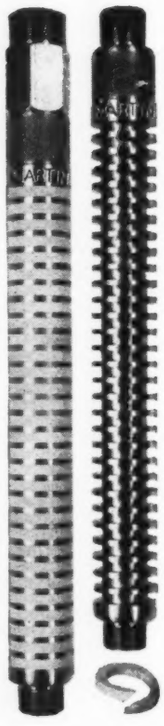
MARTIN PLUNGERS

To pump a well efficiently and economically *three problems* must be overcome.

1. **ABRASIVES.**
2. **HIGH PRESSURES.**
3. **LACK OF LUBRICATION (in the case of salt water).**

Martin Plungers solve the first two problems by using rubber, because it is the greatest abrasion resistant material known, and is water lubricated (slippery when wet). The one-piece Martin plunger body gives rigid support to the individual composition rings. Longer plungers—with more rings—handle increased pressure by keeping the pressure drop per ring within the allowable amount.

The rings are practically surrounded by rigid metal, thus limiting the absorption of oil by rubber, and reducing rubber deterioration by oil to a negligible amount.



Patent No. RE-20574

Hundreds of operators are making a handsome profit today by using Martin Plungers.

SOLD ONLY THROUGH SUPPLY STORES

Write for Illustrated Catalog or See Composite Catalog, Page 1619

FIELD REPRESENTATIVES:

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Claude Wilmeth, Kilgore, Texas
F. M. Wilson, Wichita Falls, Texas
J. B. Alexander, Odessa, Texas

JOHN N. MARTIN
Manufacturer
11 W. Brady St. Tulsa, Okla.

inwardly to eliminate possible wearing and tearing. No mechanically applied force or pressure differential is necessary to cause the packing to expand and shut-off. Because the natural shape of the Neoprene affects the seal and it is not necessary to compress the element to cause it to "cold flow," no unnecessary stress and strain are left in the present elements. This minimizes the vulcanizing of the elements to the casing walls. The flexibility of this packing is best shown by tests that proved they shut-off perfectly against pressure ranging from 1 to 7500 lb. per sq. in.

The principal usages of the pressure lock packer are (1) to hold a column of mud in the casing annulus, (2) for two-zone production, (3) to set 300 ft. to 1000 ft. below surface to protect well from flowing wild due to damage to surface connections, and (4) for two-zone pumping.

Two-Wheeled Welding Machine Trailer

A NEW two-wheeled, light-weight, pneumatic-tired trailer for mounting arc-welding machines for easy, fast portability in shop, yard, or on the road, is announced by The Lincoln Electric Company, Cleveland, Ohio, manufacturers of arc-welding equipment.

Designed for mounting either Lincoln SAE 200- to 600-amp. a-c. motor-driven or Type SA 200 special engine-driven Lincoln arc welders, the new unit can be used for road towing at speeds to approximately 30 miles per hour, can be hitched to a factory mule or industrial truck, and is easily moved by hand by virtue of the low, underslung construction, narrow 31-in. tread, and method of balancing. It is of arc-welded steel construction throughout.

Mounting is readily accomplished by means of four bolts in the frame of the trailer that register with holes in lugs on the welding machine.

The combination tow bar and standing support has a hand-operated ratchet arrangement for locking the support arm in position.

The unit measures 66 in. long, 42 in. wide, 16 in. high (over tires) and weighs 282 lb. Tires are 16-in. by 5.50-in. 4-ply.

Air Circuit Breaker

DESIGNED especially for use in industrial, central station, or power plants where operation under repetitive duty cycles is required, a new and compact circuit breaker is announced by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania. The new type DK breaker is available in 15,000 and 25,000 amp. interrupting capacities in all standard current ratings from 15 to 600 amp.

Williams' Striking Face Box "Superrench"

THE striking face box "Superrench" is a new pattern recently added to the Williams' line of "Superrenches," and is said to be particularly adapted for heavy work in close quarters where large nuts must be set-up tight or "frozen" nuts loosened. The offset head provides ample nut clearance.

Available in 10 sizes with 12-point openings, $1\frac{1}{16}$ to $2\frac{3}{4}$ in., for U. S. standard nuts $\frac{5}{8}$ to $1\frac{3}{4}$ in. The tool is drop-forged from chrome-molybde-

num steel and is properly heat-treated to withstand shock loads. The finish is in baked, gray enamel overall. The manufacturer is J. H. Williams and Company, 225 Lafayette Street, New York City.

WE MAY HAVE TO SAY *NO!*

● The Twin Disc Clutch Company is solidly behind the National Defense Program. Priorities are being given the right-of-way. This, you, as a patriotic citizen will agree, is the right attitude to take even though it may mean some sacrifice on your part when we have to say "No" to your urgent requests for immediate delivery of a new clutch.

With our greatly increased facilities, a part of our production can be devoted to non-priority business if you, as a valued customer, will cooperate by anticipating your needs and not asking for an impossible delivery date.

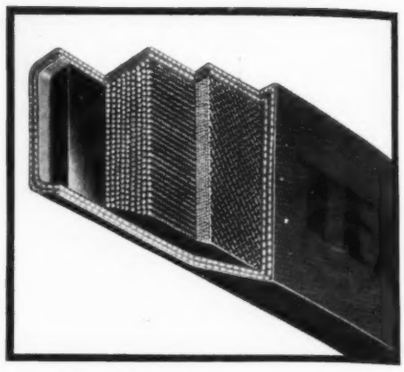
Through our 28 parts stations, we have been able to keep owners of Twin Disc-equipped machines supplied with needed parts and we expect to be able to maintain this service. TWIN DISC CLUTCH COMPANY, 1329 Racine Street, Racine, Wisconsin.

Illustrated: Twin Disc Model E Heavy-Duty Clutch (left) and Twin Disc Power Take-off.

"Super 7" V-Belt

ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, Wisconsin, has again made fundamental improvements in V-belt structure. It announces that all its Texrope V-belts are now of the new "Super 7" laminated design, based on the Vogt formula and abundant field experience, to include more strength and flexibility, greater service, and longer life.

The cords in the new "Super 7" belts are smaller, permitting the use of more cords per belt with a resulting greater strength and less stretch, it is stated. Each cord is individually imbedded in heat-dissipating rubber to reduce internal belt degeneration. These belts are made in matched sets to assure uniform, smooth running, highly efficient drives. Each element of the belt is designed to fulfill an individual function. The live rubber bottom cushion absorbs the ceaseless impacts of operation. The central cord portion transmits power at the effective pitch diameter. The bias cut fabric prevents "dishing" and assures transverse stability. The 2-ply rubber-impregnated fabric cover prevents destructive agents from reaching the vital belt elements, resulting in a high grip coefficient between belt and sheave walls.



Designed to Insure Maximum Safety

One of the outstanding features of the McKissick Floor Block is its SAFETY. The guards are so constructed that they do not need to be detached for the purpose of threading the line. Minimum wear on line and sheave is assured due to the use of the Universal Adapter which allows plenty of side sway. A ball bearing swivel assembly permits the block to freely swivel under heaviest loads. Safety Floor Blocks are available in four sizes with single bearing, and two additional sizes with double bearings — sheave diameters from 12" to 24".

SAFETY Floor Block

SAFETY Tubing Block

Safety is also a feature of McKissick Tubing Blocks. It is permanently guarded—shorter in length and is completely constructed of steel. The new latch type becket eliminates all possibility of elevator links or hooks becoming detached.

To thread this block it is only necessary to remove one bolt, which allows guard plate to swing. Elevator links or hook may be inserted without removing becket from block. These blocks are manufactured in an extremely wide range of sizes and with any number of sheaves desired. Furnished with high load roller bearings or high speed bronze bushings—also with regular latch type becket or universal ball bearing swivel becket.

See Composite Catalog — Page 1652 for complete description and prices

McKISSICK PRODUCTS CORP'N

EXPORT OFFICE — 149 BROADWAY, NEW YORK CITY

TULSA, OKLAHOMA

Retrievable Drop-In Type Back-Pressure Valve

A BACK-PRESSURE valve that can be installed to act as a drill pipe float before running the drill string, or can be dropped in after the pipe is partly in the hole, and can be removed before drilling is begun, so that the fluid passage will be open for running wire-line core barrels and other tools, is marketed by the Hydril Company, 714 West Olympic Boulevard, Los Angeles, California.

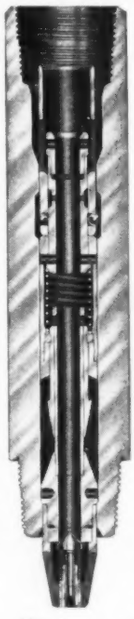


Fig. 1

Fig. 2

This device, designated a Retrievable Drop-In Type Back-Pressure Valve, is designed to prevent back flow through the pipe during running and pulling drill pipe, casing, and tubing when no permanent back-pressure valve is desired in the string.

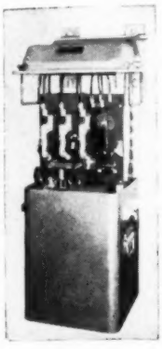
The equipment consists of a special sub, the drop-in valve body, and a retrieving tool. The valve body is shown in the sealing position in Fig. 1, the retrieving tool in Fig. 2. The sub is made-up in the string, usually just above the drill collars. When dropped down the drill pipe, the valve body stops at the slight restriction in the lower end of the sub and is automatically locked in place by a series of balls that project into the recess in the bore of the sub. Pressure from below against the expander squeezes the packer into

tight sealing contact, halting upward flow of fluid. Downward circulation and drainage are permitted by the small valve in the nose of the expander.

To retrieve the valve body, the retrieving tool is attached to a wire line below a sinker bar and is run down the drill pipe. The retrieving tool forces the mandrel downward against the spring, allowing the balls to recede into the inner groove while the slips engage the upper sleeve. The valve body can then be withdrawn from the pipe, leaving the fluid passage open.

Low-Voltage Oil-Immersed Starters

TWO new low-voltage oil-immersed starters, especially designed to resist the corrosive fumes commonly present in chemical plants and refineries, have been announced by the General Electric Company, Schenectady, New York. Designated CR7008 and CR7006, these wall-mounted starters feature a heavy, corrosion-resisting, cast-iron head supporting the mechanism and oil tank. Stainless steel nameplates and corrosion-resisting hardware further protect them against damage. The working parts are enclosed in a $\frac{3}{32}$-in. steel tank.



Special provision is made in the head for simplified installation. Conduit entrance is provided for on the top, bottom, rear, and sides of the starter, thus eliminating right-angle fittings.

The Type CR7008 is a combination starter, combining in a single unit all the equipment necessary for controlling and protecting a motor. It includes a manually operated circuit breaker for short-circuit protection and disconnecting, and a magnetic starter for push-button control of the motor.

The Type CR7006 is a magnetic starter similar to CR7008, except that it does not include the manual circuit breaker and its operating handle in the cover. It is recommended for use where other provision has been made for short-circuit protection and disconnecting.

Both CR7006 and CR7008 starters are available in types for use in hazardous-gas locations. These types are provided with extra-deep tanks, and connections, terminals, and contact tips are at least 6 in. beneath the oil level. A bull's-eye oil-level gauge is provided for inspection of the oil level.

Flexible Air Hose

A NEW lightweight air hose so flexible that the ½-in. size can be bent to a 3-in. radius without collapsing or cutting off the air supply is announced by The B. F. Goodrich Company, Akron, Ohio.

The hose has been designed so that strength and efficiency are combined with minimum weight and ease of handling and should have particular appeal to shop men handling pneumatic tools, the company's announcement says.

Made in a light gray that stands out prominently and is easy to see, the new hose is stocked in ½- and ¾-in. sizes. Of two-braid construction, the hose can easily withstand working pressures of from 80 to 125 lb., it is stated.

Compound of the tube is of oil resistant rubber, with excellent heat resisting characteristics. The tube does not flake or clog tools. Yarn reinforcement affords a safety factor of more than five to one under a working pressure of 125 lb., whereas the golden ply insulation has been especially developed to assist in flexibility and resistance to kinking.

Chances are you'll never snag a Chinaman, but

THE DEEPER YOU DRILL...

...THE MORE YOU NEED these 4 advantages of J-M 420 ROTARY LINING

1. **UNUSUALLY EVEN FEED-OFF,** giving better control of braking . . .
2. **HIGHER BRAKING EFFICIENCY,** even at extreme high operating temperatures . . .
3. **LONGER LIFE,** under any conditions . . .
4. **LESS RIM SCORING,** making drums last longer.

• Many producers have adopted J-M 420 as their standard lining for deep well drilling. An installation on your own rig will convince you of the many advantages of this improved lining. For details on J-M 420 and other J-M Friction Materials, write Johns-Manville, 22 East 40th Street, New York, N. Y.

JM Johns-Manville 420 ROTARY LINING

Portable Acetylene Generator

A NEW portable acetylene generator for use in oxyacetylene welding and cutting has been announced by The Linde Air Products Company, a unit of Union Carbide and Carbon Corporation. This generator, known as the Oxweld MP-10, will deliver 30 cu. ft. of acetylene per hour and is suitable for welding metal to ⅜ in. thick, and for cutting steel to 5 in. thick. It is designed for maximum portability, from a standpoint of weight and height, and can readily be moved about the shop or away from the shop for outside jobs. The generator can be recharged speedily, and is simple and easy to operate.

Generation of acetylene is started, set for regular operation, and stopped, by rotating the single pair of operating handles at the top of the generator. Once the operating handles have been set, generation of acetylene proceeds automatically. The pressure of acetylene delivered to the blowpipe is controlled by a regulator that forms an integral part of the generator, and a separate pressure gauge indicates at all times the pressure within the generating chamber.

Other construction features of the MP-10 generator include two relief valves that automatically vent any excessive pressures that should develop within the generator or in the delivery hose, and a hydraulic back-pressure valve that, by providing a water seal between the hose and generator, prevents any reverse flow of gas.

The carbide hopper holds 15 lb. of 14 ND Union Carbide.

Non-Slip Footwear for Oil Industry

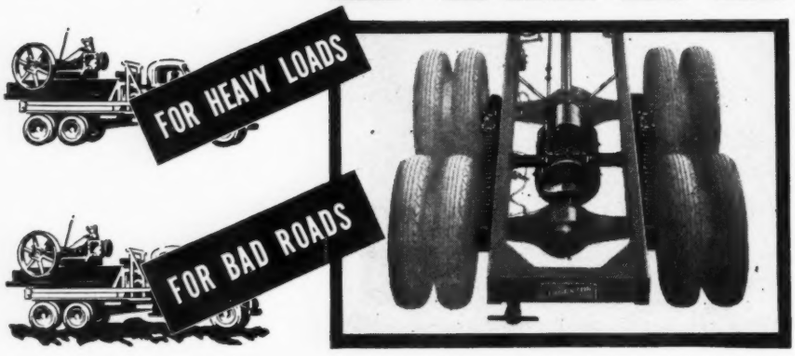
A NEW type of footwear with patented non-slip sole to halt accidents has been especially designed for the oil industry by United States Rubber Company.

Known as the Sperry Top-Sider the unusual sole was originated by Paul Sperry, an experienced yachtman, to insure safe footing on the most dangerous decks. It is in very wide use today in the sailing world.

On the straight-away this sole is perfectly smooth, and being made of pure white rubber leaves no mark on any surface. In action thousands of small rubber waves upen up to create a squeegee effect.

Because of the wide acceptance by yatchsmen, U. S. Rubber believed the sole might have extensive application in industry. Special studies were therefore begun to determine which types of workers would be aided by footwear which will not skid, even under water.

THORNTON 4-REAR-WHEEL DRIVE



In these days when *transportation* must sustain in the heavy demands of defense and industrial programs, THORNTON Four-Rear-Wheel DRIVE is rendering a tremendous service in scores of industries. With its application to trucks up to 3-ton rating, it supplies double the tractive effort and more than twice the payload capacity.

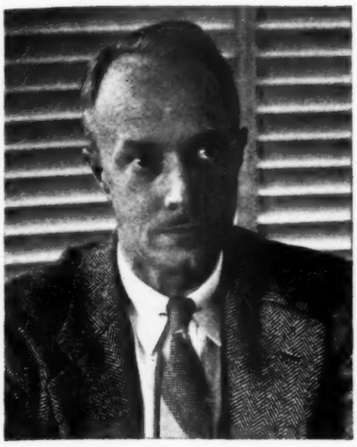
This unit is giving vital aid in solving defense transportation problems.

Engineered paricularly to meet YOUR requirements, your THORNTON-equipped trucks will carry their bigger loads faster, more economically and, if necessary, through tougher going. "Walking-Beam" dual suspension reduces shock on load and road. Write today for details concerning the application of this unit to your own hauling problems.

THORNTON TANDEM CO.
8733-8779 GRINNELL AVE. DETROIT, MICH.
Manufacturers also of the THORNTON automatic-locking DIFFERENTIAL
"When you need TRACTION you need THORNTON"

Dr. R. M. Otis Joins Lane-Wells

Dr. Russell Morley Otis has joined the engineering staff of Lane-Wells Company according to an announcement made recently by Norman L. Dorn, Lane-Wells vice-president and chief engineer.



DR. R. M. OTIS

Dr. Otis, a graduate of the California Institute of Technology, is a well-known research engineer and physicist. His experience includes research work with the Bell Telephone Laboratories, three years as director of research for the Hughes Development Company, research work in color films with Multi-Color, Ltd., research and patent engineering work for the Burt-Warner Power Corporation, wing stress analysis work for the Manta Aircraft Corporation, and several years as an independent research counselor and patent attorney.

Dr. Otis will be engaged in electrical research, working on special technical problems.

MacArthur, Link-Belt Secretary, Retires

Announcement is made by Link-Belt Company, Chicago, Illinois, that F. V. MacArthur, after nearly 50 years' service, has resigned as secretary and assistant treasurer of the company, and is retiring from business.

F.V. MacArthur

H. E. Kellogg

Harry E. Kellogg, treasurer and assistant secretary, has been elected secretary, thus becoming secretary and treasurer.

Melbourne P. Anderson, formerly general accountant, has been appointed assistant treasurer, and Henry C. Oakes, statistician, has been named to the position of assistant secretary.

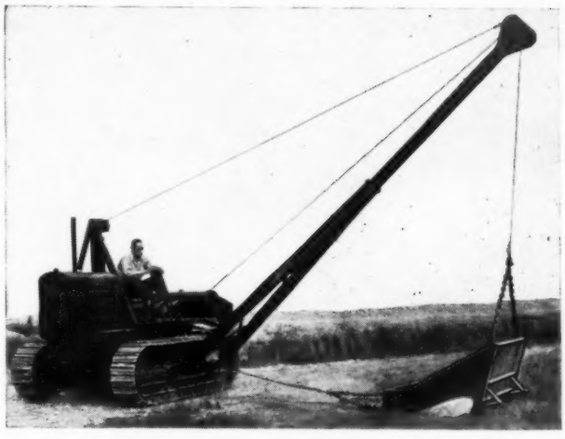
Frank H. Brandt has been appointed general auditor.

J. W. Snavely Returns to Milwaukee

Chain Belt Company, Milwaukee, Wisconsin, has announced that J. Walter Snavely, district manager in the Houston, Texas, territory for seven years, has returned to the sales department of the conveying and engineering products division at Milwaukee. Snavely graduated from the University of Wisconsin and entered the employ of Chain Belt Company as a student apprentice in the year 1927. The next three years, he spent in the factory receiving training and experience in the various manufacturing departments.

J. W. SNAVELY

The CLEVELAND MODEL "90" BACKFILLER and PIPE CRANE—



A ONE-MAN OPERATED MACHINE that Puts Pipeline Backfilling on a New High Plane of SPEED and EFFICIENCY

•

PLUS Giving You a SIDE-BOOM OUTFIT for PIPE HANDLING

Built to do today's jobs, cheaper and better, the MODEL "90" is your answer to the backfill question.

Here are some of the reasons why:

- It is continuous in operation, travels as it works.
- Has power and line speeds to make rapid passes with full load of dirt.
- Usable on every job—big or small ditch, rough or level ground, and creek-crossings, too.
- Has low center of gravity plus large, long-wearing crawlers.
- Fast travel speeds, with large variety of working speeds.
- Causes no additional crop damage.
- **AND MORE**—In a jiffy, boom can be telescoped, the drum transmission lever shifted to low—and you have a highly efficient sideboom outfit for pipe handling.

Sold on a guaranteed satisfaction basis . . . Get the details today.

THE CLEVELAND TRENCHER COMPANY

"Pioneers of the Small Trencher"

20100 ST. CLAIR AVENUE CLEVELAND, OHIO

Pittsburgh-National Meter Men Hold Breakfast Meetings at A. W. W. A.

With 36 representatives present, the Pittsburgh Equitable Meter Company had an excellent turnout at the recent A. W. W. A. convention. Col. W. F. Rockwell, president of the firm, presided at a series of breakfast conferences for the group which included salesmen from both the Pittsburgh and National divisions as well as factory executive personnel. The recently announced Empire Streamline meter was thoroughly discussed at these meetings and general matters of sales policy were covered.

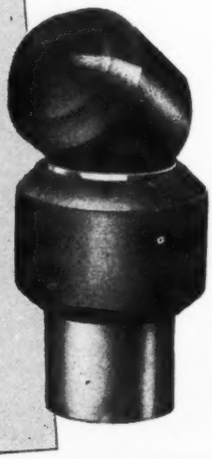
Front row, seated, left to right: P. R. Carlon, A. L. Fritchey, W. A. Wood, A. J. Kerr, C. R. Zeskey, C. F. Thomas, Col. W. F. Rockwell, Capt. A. E. Higgins, G. E. Gleeson, N. J. Kenny, M. J. Harper, A. R. Whittaker, W. F. Parker.

Second row, standing, left to right: H. L. McLaughlin, Daniel Gannon, W. L. Herron, T. R. Finley, F. W. Hartman, F. R. McDonald, Z. A. Stanfield, F. A. Lucas, A. B. Crossman, C. C. Moore, W. C. Noyes, E. C. Hidlay, D. D. Foster, John McKague, E. P. Lufkin.
Third row, standing, left to right: F. C. Taylor, R. S. Reed, Jr., George Bender, N. Stuart Mills, Fred Simpson, Ross Burns, L. A. Dixon, R. H. Smith, J. W. Fleet, V. H. McClure, J. N. Kint.

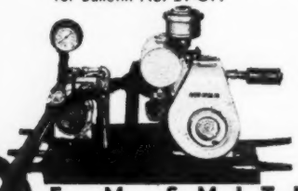
HYDRAULIC INSTALLATION

Insures The Tightest Possible Grip On Drill Pipe

2¼" I. D. for use on 4½" drill pipe.



Installation of Grizzly "Hug-Tite" Protectors and Stabilizers with special equipment, operated by tremendous hydraulic pressure, insures the tightest grip on the pipe that is possible by any method. It permits making rubbers of the toughest, strongest stock . . . as tough as rubber can be made; and with a much smaller inside diameter . . . half that of the drill pipe. The result is minimum tendency to move from positions installed, plus long life and better protection under the most severe service. . . . Ask your supply dealer about Grizzly "Hug-Tite," or write your nearest Grizzly office for Bulletin No. 21-OF.



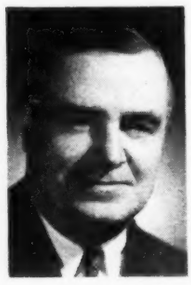
Left: Part of field equipment used for installing Grizzly "Hug-Tite" Drill Pipe Protectors and Stabilizers at the well . . . as drill pipe is run in the hole, or while it is on the pipe rack. Saves time, labor and money, and eliminates many drilling troubles.

E. M. SMITH COMPANY
600-650 South Clarence Street, Los Angeles, Calif., U. S. A.
Complete Stocks Maintained in Our Warehouses at:
407 Velasco Street, Houston, Texas — 1008 S. E. 29th Street, Oklahoma City, Okla.
1621 East Yellowstone, Casper, Wyo.
Export Office: Continental Emsco Company, 30 Rockefeller Plaza, New York City, New York
Distributed by Leading Supply Companies

GRIZZLY "HUG-TITE"
DRILL PIPE PROTECTORS & STABILIZERS

J. M. Bowlby New Chief of Eagle-Picher

The Eagle-Picher Lead Company, Cincinnati, Ohio, has announced the election of J. M. Bowlby as its new president, to succeed Joseph Hummel, Jr. Hummel, who has been associated with Eagle-Picher for 50 years, had asked to be relieved of his active duties, and was elected to be chairman of the board.



J. M. BOWLBY

The new Eagle-Picher head is a native of Litchfield, Illinois. He began his career with Railway Steel-Spring Company, now a division of American Locomotive Company. Following a varied experience in commercial and investment banking fields, he served in the United States military forces, both at home and abroad, rising to the rank of Major.

Upon conclusion of the war, Bowlby was drafted by the director of sales of the United States War Department and, as chief of the Machine Tool Section, negotiated the sale of many millions of dollars of surplus equipment to France, Belgium, Poland, and other countries.

In 1921 he became associated with Barrow, Wade, Guthrie and Company, accountants and auditors, and has been a general partner of that firm since 1928. He will assume his new position at Eagle-Picher on September 1.

Cameron Iron Works Receives U. S. Navy Award

Rear Admiral William H. P. Blandy, chief of the Bureau of Ordnance, Navy Department, recently presented to Edmund L. Lorehn, vice-president of Cameron Iron Works, Inc., Houston, Texas, the coveted "Navy E". Cameron Iron works was one of the 14 manufacturers given such an award. In making the "E" awards at a ceremony at Washington, July 25, Secretary of the Navy Knox said:

"Anybody familiar with the Navy knows what the letter 'E' means on the bridge, conning tower, funnel or turret of a naval vessel. It's the highest service award the Navy can make and it means excellence or special merit in gunnery or engineering or some other activity. It's the Navy's way of saying 'well done!'

"In the present defense program, we've asked for miracles of industrial production and, what's more, we're getting them. To show our appreciation of the way American industry has gone to bat in this emergency, the Navy has decided to award the Bureau of Ordnance flag and its coveted 'E' to the management and men of those plants who are doing an outstanding job in the production of naval ordnance material. Again, it's our way of saying 'well done!' "

R. B. Whyte Made Vice-President Macwhyte Company

In acknowledgment of his outstanding services as general superintendent, the directors of Macwhyte Company, Kenosha, Wisconsin, at a recent meeting voted Robert B. Whyte vice-president in charge of operations.

R. B. WHYTE

His connection with the wire and wire rope industry dates back to 1913 when he left Cornell with a degree in mechanical engineering. In 1917 he resigned his position in other mills to become wire mill superintendent of Macwhyte Company. It was not long before his industry and skill were acknowledged because in 1925 he was made general factory superintendent.

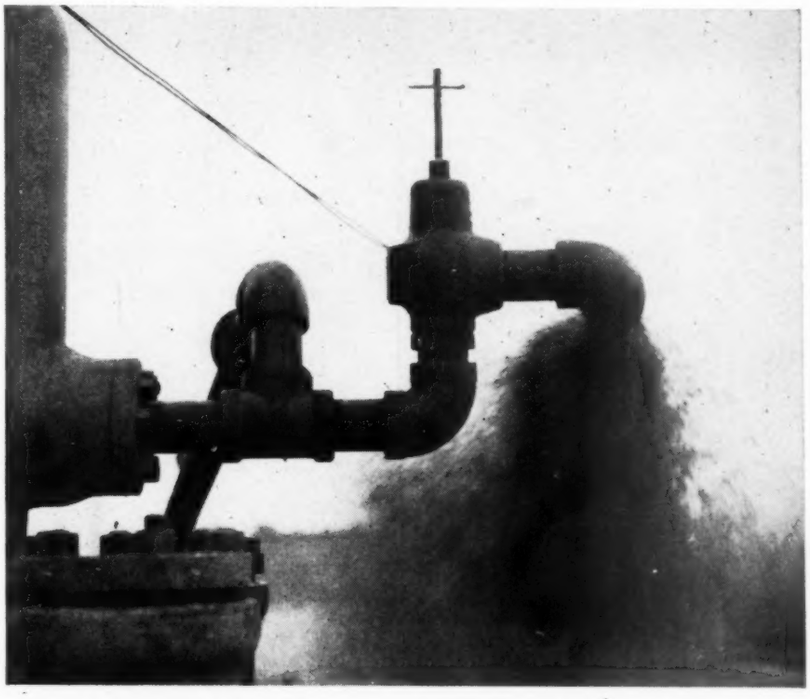
In 1937 he was elected a director, and now in 1941 he has again been rewarded by the directors with a new office.

Other officers of Macwhyte Company are: George S. Whyte, chairman of the board; Jessel S. Whyte, president and general manager; H. E. Sawyer, vice-president and treasurer; Howard Gay, secretary, and M. A. Buntrock, assistant secretary and assistant treasurer.

Capt. A. E. Higgin Is Very Much Alive

"The reports of my death were greatly exaggerated." So, in the words of Mark Twain, stated Captain A. E. Higgins, the flying vice-president of the Pittsburgh Equitable Meter Company. It was all caused by a syndicated newspaper report of an airplane crash in which a pilot of the same name figured. The wires leading into the Pittsburgh firm were jammed with inquiries from many anxious friends following publication of the misleading item.

For the records, it might be stated that Captain Higgins, a veteran aviator, who has piloted his own plane, without incident, on three round trips, coast to coast, since the first of this year, is still very much alive today. He recently ferried Colonel W. F. Rockwell, president of the Pittsburgh Equitable Meter Company, to and from the American Water Works Association convention in Toronto.



ANOTHER NAIL BITES THE DUST

Damage To Pump Parts:
NONE!

Here's an action picture of just what happens when slush pump pressure reaches the shear stress in an Abercrombie SHEAR-RELIEF Valve. The stainless steel valve stem through which the nail is set (nail size depending on pressure against which the operator wants protection) is forced by the neoprene piston to shear the nail at the set point. The piston is then forced upward, out of the path of the slush, which escapes through an outlet. The pump is momentarily shut down and the SHEAR-RELIEF Valve reset by moving the piston by hand back into place and inserting another nail through the nail hole in the stainless steel stem. Note, in the picture, how the valve stem is raised out of place following shearing of the nail, which is lying on the ground in two pieces. Note, also, the hardened steel pin near the top of the stem. It is used for moving the stem up or down to setting position.

This safe, sure, low-cost means of avoiding blow-up of pumps and pump parts has put SHEAR-RELIEF Valves on oil field pumps everywhere.

FLUID-PISTON SLUSH PUMPS
ABERCROMBIE PUMP CO.
Gulf Building Houston, Texas

SHEAR-RELIEF VALVE

LUFKIN
CHROME CLAD
STEEL TAPES

Tired of trying to use a hard-to-read, old fashioned steel tape with worn off markings? Then now's the time to get your new Lufkin "Anchor"—the tape with the Chrome Clad Line that oilmen everywhere are praising. Its jet black markings are easy to read against the satin chrome surface that won't rust, crack chip or peel. The genuine leather, hand stitched case is pleasing to handle and as sturdy as the line it holds. To really appreciate the "Anchor" you should ask your dealer to let you see it. Write us for free Catalog.

LUFKIN
SAGINAW, MICH. New York City
TAPES—RULES—PRECISION TOOLS

Frick-Reid Organizes Equipment Exchange Division

J. L. Shakely, president of Frick-Reid Supply Corporation, Tulsa, Oklahoma, announces the organization of an "Equipment Exchange Division," which will offer a new service to the oil industry.

J. S. DEWAR

The new division will be headed by J. S. (Stewart) Dewar, as general manager. Dewar is well-known to the oil industry, having been associated with several major companies in field and executive capacities for 20 years, and for the last several years has been operating as an independent producer.

The function of the division will be to exchange or purchase surplus equipment of producing, pipe line, and refining companies, making such equipment available to others who have need for it.

Oakite Issues Cleaning Manual

With producing and refining equipment being operated at greatly increased capacity, and pipe line facilities being rapidly expanded to assure an ample supply of petroleum products primarily for National Defense requirements, oil companies are now faced with the problem of meeting increased maintenance on a faster, more effective basis than ever before.

Of timely interest in this connection is the newly revised, third edition of an illustrated, 20-page cleaning manual just issued by Oakite Products, Inc., New York, containing many time-saving tips on the maintenance of more than 24 different types of water-circulating or water-cooled operating equipment.

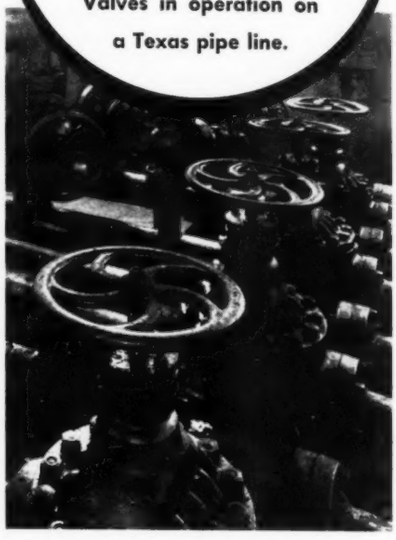
Copies of this booklet are available upon request. Write to Oakite Products, Inc., 48 Thames Street, New York, New York.

Schlumberger Buys Plane for Britain

The Schlumberger Oil Well Surveying Corporation, Houston, Texas, has wired $20,000 to the Wings for Britain fund in Montreal to buy a Spitfire fighter plane for the Allies. The firm asked that the plane be christened "French Hope" and said they would be glad to receive news of "our fighter" from time to time.

UNDER CONTROL

Ludlow Double-Disc Gate Valves in operation on a Texas pipe line.



Our vast network of pipe lines is an important asset — more than ever vital to our national well-being.

Ludlow Double-Disc Gate Valves play an important part in pipe line operations. At all times—under gruelling operating conditions and high pressures—they keep things under control. Write for specifications and prices. There's a Ludlow valve available for any standard purpose and we design and build valves for special applications.

The Ludlow Principle of valve construction — parallel seat double-disc gate type—has been universally accepted and preferred for oil, gas, and water lines since 1866.

The LUDLOW VALVE MFG·CO·INC· SINCE 1866 TROY·N·Y·

SAFETY PLUS

SAND-BANUM surely and SAFELY removes old and prevents new boiler scale and corrosion.

"The Entirely Different Boiler and Engine Treatment"

SAND-BANUM is a Pure Colloidal preparation free of the usual "boiler compound chemicals," without silicate of soda, soda ash or caustic soda.

That's why it's so safe and certain, yet absolutely harmless to personnel and equipment.

Be Safe
and Certain
the Economical
SAND-BANUM WAY!

•

AMERICAN SAND-BANUM COMPANY, Inc.
9 Rockefeller Plaza
New York City

Stocks carried by
WESTERN SAND-BANUM COMPANY
Houston, Texas **Fresno, California**
and at other convenient points including leading supply houses

•

Export Representatives
PETROLEUM MACHINERY CORP.
30 Rockefeller Plaza **New York City**

N.G.A.A. Technical Committee Appointed

Personnel of the important Technical Committee of the Natural Gasoline Association of America for the 1941-42 working year has been announced by Ray E. Miller, Hanlon-Buchanan, Inc., president of the association.

H. H. Beeson, vice-president of the Sabine Valley Gasoline Company, Shreveport, Louisiana, was appointed chairman of the committee, succeeding C. R. Williams, Continental Oil Company, who is on a special assignment for his company in Baltimore, Maryland. C. E. Wharton, Hanlon-Buchanan, Inc., Gladewater, Texas, was appointed vice chairman.

Other members of the committee are: R. C. Alden, Phillips Petroleum Company, Bartlesville, Oklahoma; L. A. Boyd, Warren Petroleum Corporation, Tulsa, Oklahoma; M. R. Church, Shell Oil Company, Inc., Houston, Texas; G. P. Crutchfield, Roeser and Pendleton, Inc., Fort Worth, Texas; D. B. Dow, Cities Service Company, Bartlesville; F. E. Fisher, Skelly Oil Company, Pawhuska, Oklahoma; W. F. Fulton, United Gas Pipe Line Company, Shreveport, Louisiana; R. D. Gibbs, Union Oil Company of California, Los Angeles, California; Joe Gershovitz, Parade Gasoline Company, Inc., Overton, Texas; F. B. Haverfield, Continental Oil Company, Ponca City, Oklahoma; H. J. Hunter, Coltexo Corporation, Monroe, Louisiana; Fred F. Ketchum, Owens, Libby-Owens Gas Department, Charleston, West Virginia; E. C. LeFevre, Cities Service Oil Company, Bartlesville; E. M. Parkin, Glacier Production Company, Cut Bank, Montana; N. K. Rector, Glen Rose Gasoline Company, Tulsa; C. A. Short, Lisbon Gasoline Company, Inc., Shreveport; J. L. Thompson, Lone Star Gasoline Company, Dallas, Texas; Carl Vickburg, Carter Oil Company, Tulsa, and D. M. Wolfe, Standard Oil Company of California, San Francisco.

Makes Field Survey Trip by Air

Recently promoted from territorial sales work to a position as special representative of the Plomb Tool Company, Glen Crandall is making a field survey trip by air to cover all principal cities in the country.

The survey is expected to take approximately six weeks and is for the purpose of studying marketing conditions in the various territories to facilitate improved service for Plomb Tool jobbers and users.

TWO GREAT TOOLS

THAT ARE SAVING TIME AND MONEY FOR MANY OPERATORS

THE CAVINS Perforation WASHER

For use in regular slotted perforations.

Over 460 successful jobs in one state alone shows this tool is a good bet. Opens perforations that are clogged; flushes the formation outside the pipe; prepares perforated pipe for cement jobs or water location; determines condition of outside gravel packed jobs.

THE CAVINS SCREEN CLEANER

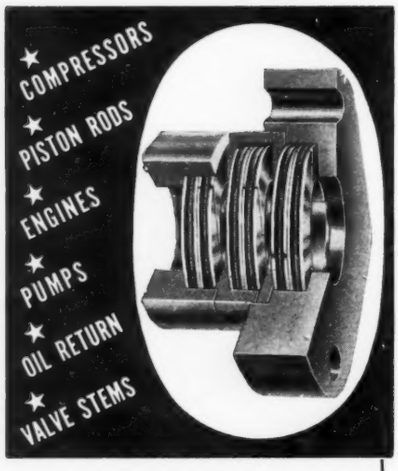
For use in wire wrapped perforations.

Rejuvenating wells with this tool is simple, easy and sure. It is run on an ordinary sand line, requiring only a two-man crew. And you'll never know how much production you've been passing up until you use it.

There's a Cavins Representative near you who will be glad to give further details.

THE CAVINS COMPANY
2853-73 Cherry Avenue, Long Beach, California
Cable Address: "Cavins, Long Beach"
Foreign Representative: R. J. Eiche

Branches and Service Representatives Located At: Long Beach, Bakersfield, Ventura, Taft, Houston, Corpus Christi, Kilgore, Dallas, Lake Charles, Houma, Denver, Lance Creek, Ellinwood.



STAR PERFORMANCE in Any Packing Job

For nearly half a century, France "Full-floating" Metal Packing has been used the world over for sealing piston rods in any type of reciprocating engine, pump or compressor as well as valve stems, whether reciprocating or oscillating. A design can also be furnished to prevent crankcase oil leakage and the combined service of preventing crankcase oil leakage and condensation from entering the crankcase.

For star performance (maximum sealing efficiency with minimum maintenance expense), specify France "Full-floating" Metal Packing — the packing that L-A-S-T-S.

Original FRANCE Metal Packing — Sold on approval — Satisfaction Guaranteed

Catalog M-3 tells the complete story. Write for it.

THE FRANCE PACKING COMPANY
Tacony Philadelphia Penna.
Mid-Continent Representative:
Mr. J. M. FULLER, 2603 Azle Avenue
FORT WORTH, TEXAS

Original FRANCE METAL PACKING

Meredith Bailey Passes Away

Meredith N. Bailey, who has been active in the gas industry during the last 30 years, died July 24, at his home in Royersford, Pennsylvania.

Bailey was born on April 25, 1880, at Cape May, New Jersey. He was educated at the Cape May High School and at Deats Academy, Cape May,

MEREDITH N. BAILEY

New Jersey. Before joining the Keystone Meter Company of Royersford on July 1, 1909, he worked for several years in the plant and engineering department of the Bell Telephone Company in Pennsylvania.

When the Keystone organization was absorbed by American Meter Company in 1916, Bailey represented his company with headquarters at the 1513 Race Street factory in Philadelphia.

He was promoted to assistant manager of American Meter Company's Philadelphia plant April 17, 1935.

Record Crowd Attends Axelson Picnic

Nearly 3000 employees, their families and friends attended the twelfth annual picnic of the Axelson Manufacturing Company's Employees Welfare Association held at the Barney Oldfield Picnic Ground near Van Nuys, California.

Under the direction of Alvin "Dutch" Zwerniman, general chairman, a fast-moving program of games and entertainment for young and old got under way by nine in the morning. After lunch a baseball game between the shop and the office kept the crowd enthralled. The music of a good dance orchestra held most of the guests until nearly midnight.

Every time this Kit is used... tab it

Helps cut time lost due to infection

Even clumsy, excited fingers find the packets of iodine, bandages, swabs and countless other First Aid Items in the Bullard Weatherproof Kit easy to lift out because the side walls are low. The rubber "weather strip" tubing that seals contents against dampness or dust, also *springs* the cover when catch is released. Instant Guide to First Aid, listing injuries, symptoms and approved treatments are inside the cover. This kit, and many others — all handy to use — are described in a new handy folder "First Aid" . . . Sent free on request to: E.D. Bullard Company, 275 Eighth Street. San Francisco. B-8

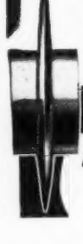
Everything BULLARD in Safety

Look for the Arm-and-Hammer
ARMSTRONG BROS.

Improved
PIPE CUTTERS

The Drop-Forged and "Combination" Pipe Cutters can be used as a 1 or 3 wheel cutter. All are improved cutters, accurately made with hardened steel pins and rollers. Thrust rods of "Saunders" type cutter are hardened at the point and bear on embedded, hardened steel block. On "Barnes Type," the thrust is taken up by drop-forged steel sections. Parts are interchangeable with other standard makes. All are Cadmium Plated.

ARMSTRONG BROS Knife Blade Cutter Wheels cut much faster and easier, hold their keen cutting edge, for they are made of Vanadium Tool Steel, heat treated, hardened, and cadmium plated.



Write today for Catalog C-39, showing the most complete line of Pipe Tools made.

ARMSTRONG BROS. TOOL COMPANY
"The Tool Holder People"
331 North Francisco Avenue
CHICAGO, U. S. A.

Plans Completed for Appalachian Meter School

A. F. Kraus, superintendent of gas measurement for the People's Natural Gas Company of Pittsburgh, Pennsylvania, in his capacity as chairman, has extended a cordial invitation to all in the gas and oil business and to those in other industries interested in measurement and regulation to attend the Appalachian Gas Measurement Short Course at West Virginia University, at Morgantown, West Virginia, on August 18, 19, and 20.

The primary aim of the school is to present, discuss, and illustrate the various problems in measurement and control of gas so that each person attending may gain practical knowledge that will help in the performance of his tasks.

According to Kraus, outstanding speakers have been obtained for the various sessions. General meetings will be held each morning in the large assembly hall where those present will be privileged to hear recognized authorities speak on various economic aspects of gas measurement and regulation. These speakers include Dr. C. E. Lawall, president of West Virginia University; C. C. Reed, Hope Natural Gas Company; Dr. Reginald L. Wakeman, Mellon Institute of Industrial Research; Dr. R. C. Colwell, physics department, West Virginia University; Judge E. B. Pennybacker, chairman, Public Service Commission of West Virginia; William A. Ehlers, Reynolds Gas Regulator Company; T. H. Kerr, The Ohio Fuel Gas Company; A. D. MacLean, Pittsburgh Equitable Meter Company; D. P. Hartson, Pittsburgh and West Virginia Gas Company; E. H. Poe, secretary, Natural Gas Section of the American Gas Association, and A. F. Benson, American Meter Company.

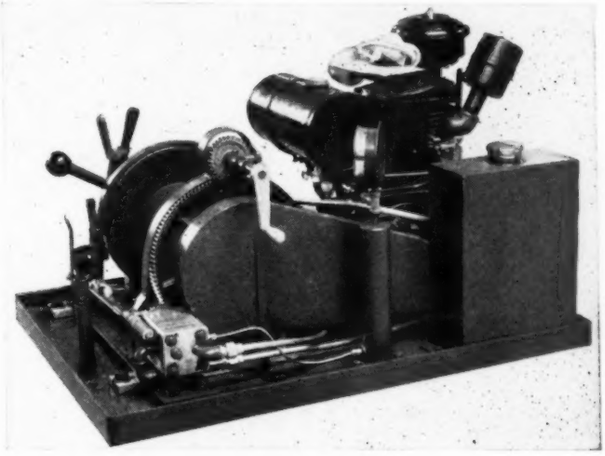
Classroom sessions of one hour and fifteen minutes each will be conducted afternoons by gas company engineers and representatives of the equipment manufacturers.

Monday evening registrants at the school will be entertained with a boxing show, whereas the annual dinner will be held Tuesday evening in the Hotel Morgan ballroom.

J. P. Magoffin With Hydril

The caption under a picture of J. P. Magoffin in the July issue of *The Petroleum Engineer* inaccurately stated he was a representative of the Byron Jackson Company. Magoffin is, and has been for a number of years, with the Hydril Company.

WELL MEASURING



WELL SURVEYING

Mathey *portable* Measuring Units

Seven different models of Mathey portable measuring units are available for any depth of work. Reels have capacities from 5,000 feet to 15,000 feet of .072 line. Units may be mounted in trailers, automobiles, pulling units, and core drills. They are available as self-powered gasoline engine units or power take-off models.

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• When this operator rigged up for a deep wildcat test well in the Mississippi river swamps, he selected the best available rotary drilling equipment money could buy . . . including mud screens. This picture shows the dual hookup of Link-Belt NRM-124 vibrating mud screens doing a good job of mud-conditioning.

This unique dual unit consists of two 24" x 48" mud screens, mounted on skids as one unit, and having but one mud-collecting tank and inlet chute. Each screen panel is vibrated independently, although driven from a single source of power.

Write today for Folder No. 1872-A, which gives full mechanical details and operating advantages.

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LINK-BELT MUD SCREEN

Pittsburgh Equitable Acquires Larsson Machine Tool Works

President W. F. Rockwell of the Pittsburgh Equitable Meter Company announces that his firm has acquired the assets of the Larsson Machine Tool Works of Berkeley, California. This acquisition provides the Pittsburgh firm with a modern self-contained tool plant fully equipped to manufacture dies, tools and special equipment. It was stated that the present business would be continued and that these additional facilities would also be utilized for experimental work on a number of new products that are under development.

V. R. Smith Joins Macwhyte Company

Vodrie R. Smith has recently been appointed sales representative of Macwhyte Company. He will have his headquarters in Houston, Texas. Smith for several years was with the Gulf Oil Corporation in the Gulf Coast district and is familiar with oil operations in that territory.

THIS IS THE BANK *for* OIL MEN

At the First National in Dallas oil men find a sympathetic understanding of their problems and a sincere desire to cooperate in meeting their loan requirements. This accounts for the fact that so many oil men refer to the First National as "That's My Bank."

FIRST NATIONAL BANK
IN DALLAS MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

D. R. Brown Heads New Firm

A broad background of 21 years experience in supplying oil country needs was injected into the national defense effort recently when Douglas R. Brown became president of the newly formed Multiscope, Inc., Coffeyville, Kansas. Brown was formerly president of OCS Manufacturing Company. The list of incorporators also included Eldon J. Lowe, formerly purchasing agent for OCS. Other incorporators included: E. F. Buckley, vice-president; B. L. Perry, chairman of the board, and C. D. Welch, counselor.

The state department at Topeka, Kansas, filed the articles of incorporation, listing $100,000 capitalization. The new firm will be located at Coffeyville, on property formerly used by the old Kansas oil refinery. One of the larger refinery structures will provide 6000 ft. of floor space for the new concern.

Brown pointed out that little could be divulged as to the nature or character of the products to be manufactured, as the firm's work has to do with supplying the government defense material.

W. R. Davis, World Famous Oil Man, Dies

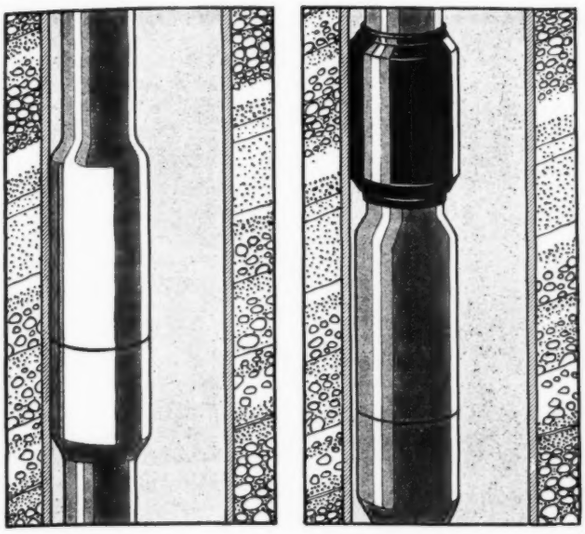
William Rhodes Davis, 52, who rose in his lifetime to a position of prominence in the petroleum industry of the world, died of a heart attack in Houston, Texas, August 1.

Davis entered the oil business in Oklahoma after serving a year in France in the first world war. Beginning as a drilling contractor, Davis began the long career that was to bring him world fame as an oil man.

As he became more successful his activities expanded to Sweden, Finland, Germany, England, and Mexico.

In 1939 Davis leased thousands of acres in Starr County, Texas, in the Rio Grande Valley where only gas production had been discovered. Oil was discovered by Davis and his associates and they sold half interest in the field for a reported $6,000,000 to Continental Oil Company. He discovered oil in Goliad County at Weser, and at West Garwood in Colorado County.

As head of the Texas Crusader Company he discovered the University field at Baton Rouge, Louisiana, and the Magnet and Kubela fields of Wharton County, Texas. He also opened production of oil on the flanks of several known salt domes along the Gulf Coast such as Bayou Choctaw and Anse le Butte, Louisiana.



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No swirling against pipe

Tightest seal around pipe

Note closely the lips added to Patterson-Ballagh Protectors. They give perfect streamlining. They prevent "ringing" of the drill pipe and erosion. Swirl of the mud is confined to the abrasion-resistant Protector instead of on the pipe. The extended lips add approximately 15 per cent more contact area with the pipe and an extra tight grip right at the edges. All these advantages result in longer life to Protectors and Pipe. Ask for details.

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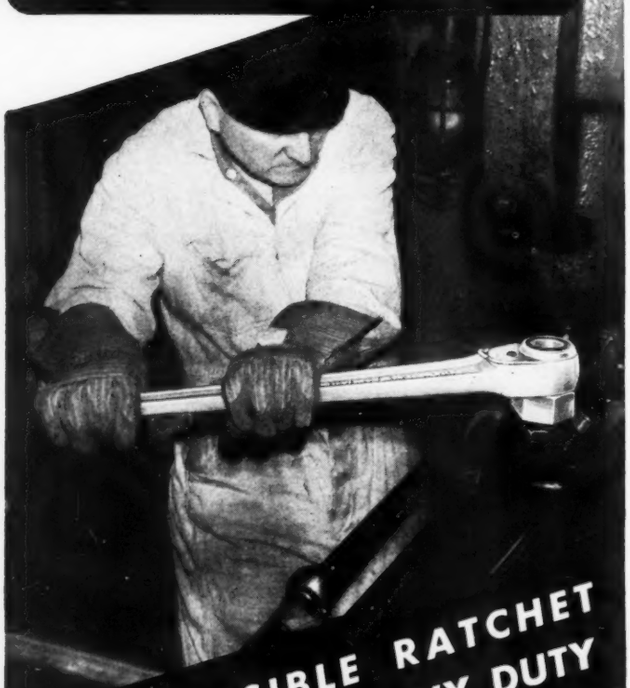
SUPERIOR DROP-FORGED TOOLS
"SUPERECTOR" WRENCHES



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● Williams "Superector" provides faster action, safer operation and greater durability under all kinds of severe service. Its quadruple pawls of hardened tool steel mean that two pawls constantly engage two teeth for both "on" and "off" rotation of nuts. Its *drop-forged* handle utilizes the extra strength afforded by these pawls.

Williams' "Superector" wrenches are made in five sizes, 24" to 53", for both hex and square sockets, 1" to 4⅝". Sockets have hole extending clear through so that nuts may be drawn down all the way on any length bolt.

See our advertisement in the Composite Catalog. Buy from your supply store.

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Book Reviews

Regulation of Pipe Lines as Common Carriers, by William Beard. Published by Columbia University Press, Morningside Heights, New York, New York. 184 pp. Price $2.00.

The author incorporates in the book the first systematic and comprehensive study of the federal and state regulation of pipe lines as common carriers. Completely explained by Beard are the designation of pipe lines as common carriers, pipe-line legislation proceedings, rate regulation and function of regulatory agencies, service regulations, pipe-line affiliations, and the coördination of pipe lines with other forms of transportation.

Appearance of the book is regarded as timely due to proposed extensions and construction of pipe lines in the Nation due to the defense program pipe-line legislation, obtainance of rights-of-way, and control.

A conclusion at the end of the book presents arguments on various subjects of importance relative to pipe lines.

Mining Engineers' Handbook (Third Edition), by Robert Peele. Published by John Wiley and Sons, Inc., New York, New York. In two volumes with 45 sections. Price, $15.

These volumes are Nos. VI and VII of the new Wiley Engineering Handbook Series. Revision of the book was made necessary by the progressiveness of mining and mining methods and mining appliances. New subject matter has been added to the text, some of the older matter omitted, and some sections almost completely rewritten.

Among the new sections of the volumes are "Petroleum Production" by S. F. Shaw and "Geophysical Prospecting" by Frederick W. Lee. Radical revision has been made of the section "Compressed Air Practices" by A. W. Loomis. Other sections of the text have been rewritten and expanded. These include "Methods of Mining," "Mine Ventilation," and "Hoisting Plant, Shaft Pockets, and Ore Bins."

Signs 100th Contract For Oil Show

Guy Tompson, vice-president of the Bethlehem Supply Corporation, signed the 100th contract for the May 16 to 23, 1942, International Petroleum Exposition at Tulsa, Oklahoma, making his firm the 100th exhibitor. General Manager William B. Way of the oil show is looking on. The Exposition set August 15 as the deadline for 1940 exhibitors to exercise the option granted them on their old space.

Sperry-Sun Awards Service Emblems

A meeting was held at the Houston office of the Sperry-Sun Well Surveying Company recently when ten-year service emblems were presented to several employees by G. L. Kothny, vice-president and general manager of the company.

The emblems are of gold and bear the insignia of Sperry-Sun: a spinning gyroscope against the background of a rising sun; as well as the words: "10 Years, Service, Loyalty, Sperry-Sun."

Ten Year Emblems were presented to the following: A. B. Palmer, district manager, Lafayette, Louisiana; R. S. Hyer, district manager, Houston, Texas; H. A. Wesner, office manager, Houston, and R. C. White, mechanic, Houston.

A Ten Year Emblem was also presented to George A. Smith of the Philadelphia law firm, Busser and Harding, who, while not a Sperry-Sun employee, has lent invaluable aid to the company since its inception in handling legal matters.

W. H. Emerson, district manager at Long Beach, California, received a Ten Year Emblem, but this was forwarded to him by mail as he could not be present at the Houston meeting.

E. M. Jolley of Marley Company Passes Away

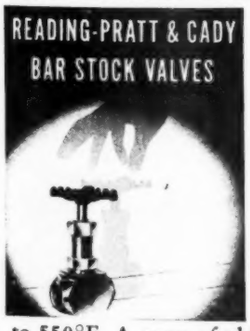
Edward M. Jolley, one of the most widely known sales engineers of the Kansas, Missouri, Nebraska, and Iowa area, succumbed to a heart attack the morning of July 3 while driving alone to Lawrence, Kansas, on a business call for The Marley Company, cooling tower manufacturers whom he has represented since the early part of 1938, operating out of the main office in Kansas City, Kansas.

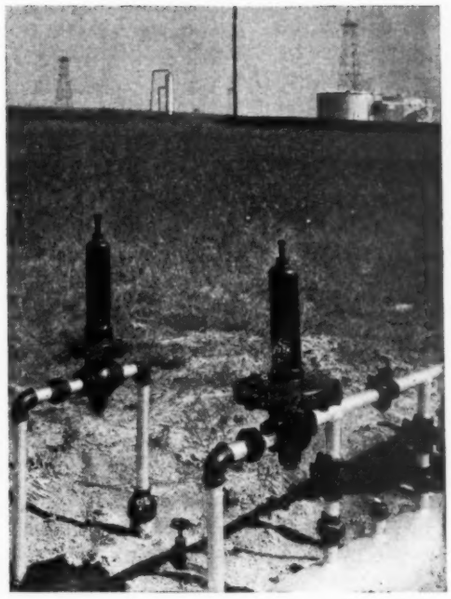
EDWARD M. JOLLEY

Jolley was graduated in mechanical engineering in 1928 from the University of Nebraska where he was a member of Pi Kappa Alpha fraternity. Born May 23, 1905, at Spearfish, South Dakota, he completed grade and high schools there. December 26, 1932, he married Katherine Hinckley of Pittsburgh, Pennsylvania. Mrs. Jolley and two daughters, aged 7 and 5, survive him.

Union Bonnet Bronze Globe and Angle Valves

A new folder on Union Bonnet Bronze Globe and Angle Valves has been published by the Reading-Pratt and Cady Division of the American Chain and Cable Company, Inc., Reading, Pennsylvania. This folder covers the new improvements on this line of valves. These valves are designed to meet the widest possible variety of service conditions, it is stated. Three types of seatings are available, regrinding, semi-plug, and full plug, as well as three seating materials, bronze, copper nickel alloy, and stainless steel (12-14 percent chromium). Steam pressure ratings range from 150 lb. with temperature ratings to 550°F. A copy of this folder can be obtained by writing the manufacturer.





Easy to deliver, easy to install, self-protective against meddling, C-F spring-loaded Regulators are preferred in some conditions of service to those of weight-and-lever type. A high-pressure and a low-pressure unit on lines of an important gas company in Texas are here illustrated. C-F meets all requirements of pressure control. Write for new Catalog.

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The COFFING "Safety-Pull" is the safest and fastest operating ratchet lever hoist built because it is the only hoist with a dual ratchet and pawl assembly, independent of each other. The load is always under control. There is no clutch to slip or drop load. Portable - Lightweight - for Pulling or Lifting. Capacities ¾ to 15 tons, weighing from 14 to 150 pounds.

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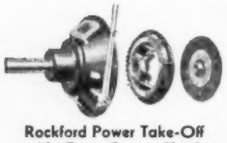
Rockford Spring-Loaded Clutch

Products of long experience in making clutches for all kinds of industrial service; Rockford Clutches provide reliable, economical control that matches the efficient performance of modern industrial engines. For this reason, they are increasingly popular and widely used in oil field power units; as well as in leading tractors and various producing equipment units.



Rockford Power Take-Off with Over-Center Clutch

Rockford Clutches are made in Over-Center and Spring-Loaded types, in many standard sizes; available also in Rockford Power Take-Offs for S.A.E. flywheel housings. Full information on request.

Equipment manufacturers are invited to use our experienced engineering service, without obligation, for developing applications. Investigate, write for information.

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TRADE LITERATURE

What to Write For

COFFING HOIST COMPANY, Danville, Illinois, has released a catalog on the Coffing "Safety-Pull" hoist; sent on request.

LITERATURE AND SPECIFICATION sheets are available on request for Dura Seal, mechanical seal for centrifugal pumps and agitators, from Durametallic Corporation, Kalamazoo, Michigan.

THE COMPLETE STORY of France "Fullfloating" metal packing may be had by addressing The France Packing Company, Philadelphia, Pennsylvania, and requesting Catalog M-3.

DETAILED INFORMATION and prices of "Kontrol-Fan," automatic temperature control for engine temperature, will be sent on request by addressing Kontrol-Fan, Inc., 4031 Goodwin Avenue, Los Angeles, California.

"IT'S WELDING TIME" is the title of the pictorial now being released on request by The Lincoln Electric Company, Cleveland, Ohio.

MECHANICAL DETAILS of the Link-Belt mud screen are contained in Folder No. 1872-A. Copies will be sent free upon request. Address Link-Belt Company, Philadelphia, Pennsylvania, or your nearest branch office.

AN ILLUSTRATED CATALOG is available on request describing Martin Plungers, from John N. Martin Manufacturer, 11 West Brady Street, Tulsa, Oklahoma.

FULL DETAILS concerning Oakite Compound No. 32 for descaling gasoline condensers will be sent on request. Address Oakite Products, Inc., 48 Thames Street, New York, New York.

TUBE-TURNS, INC., Louisville, Kentucky, offers their data book and catalog on tube-turn fittings covering all types, sizes and weights.

MACWHYTE COMPANY, Kenosha, Wisconsin, has compiled a complete and indexed catalog of general list prices, tables and data on their wire rope. The catalog, G-14, will be sent on request.

THE BROWN INSTRUMENT COMPANY, Wayne and Roberts Avenues, Philadelphia, Pennsylvania, has just issued a new 36-page illustrated catalog containing a wealth of information for the executive, engineer, and plant-operating man. Copy of the catalog, No. 8903, will be sent on request.

BULLETIN C 415 is being released on request by Reed Roller Bit Company, P. O. Box 2119, Houston, Texas, giving full information on the Reed core drill for both wire line and conventional coring.

TWO BULLETINS, one describing the various Worthington angle engine compressors, No. 550 B19, and the other giving details concerning the Worthington centrifugal pumps, No. W-304-B2, are available to those interested. Also available is a new handbook of multi-v-drive engineering selection tables and data. Address Worthington Pump and Machinery Corporation, Harrison, New Jersey, or the nearest branch office or distributor.

Good Neighbors "Shake" Over Pipe Line

High officials of both the United States and Canada attended the ceremony during which the United States and Canadian sections of a 236-mile oil pipe line were welded at

(International News Photos)

the international border. The pipe line will join a tanker terminal in Portland, Maine, with oil refineries in Montreal. Shaking hands (top) are welders James O. Lambert, Montreal, right, and Jean Lilly of Hull, Maine. Below, Gov. William H. Willis, left, of Vermont, and Hon. C. D. Howe, Canadian Minister of Munitions and Supply, are using international teamwork in welding the pipe line.

Fred E. Cooper Holds Sales Meeting

Fred E. Cooper, Tulsa, Oklahoma, held a 3-day sales meeting and service school, July 19, 20, and 21. Salesmen of the company from points throughout the United States and Canada attended. Highlight of the meeting was the sales banquet held on Sunday night. The principal speaker was Ernest Franks, manager of power unit sales, Allis-Chalmers Manufacturing Company. Members of the Cooper organization attending the banquet were: H. B. Bloxom, Harold Cooper, E. E. Everson, Louis Gasche, C. V. Small, C. O. Work, H. R. Kramp, Ralph Marshall, W. C. Simpson, W. F. Vorhies, C. F. Nelson, J. A. Cott, Harry Farmer, John Flanagan, E. H. Cochran, Ray Kaib, C. L. Elliott, R. R. Kirkpatrick, E. P. Lee, A. G. Bailey, G. E. Plank, George McNinch, L. A. Wilsey, Earl Woolbert, Kenneth Flett, Kenneth Tate, Spence Province, Guy Reed, C. D. Houser, Howard Appleton, W. S. Ricketts, Bill Allen, and Roy Stockton.

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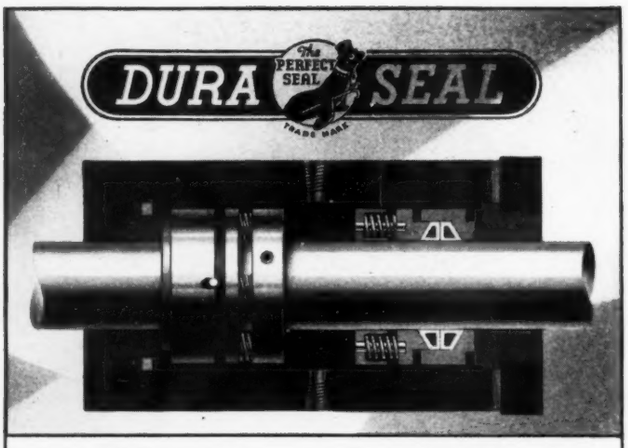

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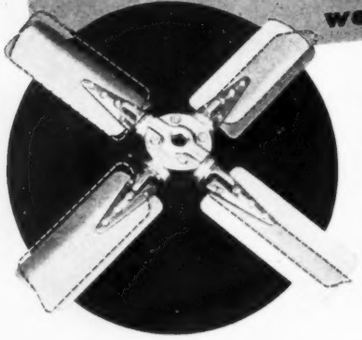
complete automatic temperature control *insures* UNIFORM ENGINE TEMPERATURE regardless of weather or load



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Radiator temperature controls the thermostat to fade fan blades in or out of pitch automatically, holding engine temperature within desired range.

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MEETINGS

Mississippi Oil Exposition—August 25, 26, 27, 28, 29, and 30, Yazoo City, Mississippi.

California Natural Gasoline Association, Monthly Meeting—September 4, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles.

American Chemical Society—September 8, 9, 10, 11, and 12, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

National Petroleum Association, 39th Annual Meeting—September 17, 18, and 19, Hotel Traymore, Atlantic City, New Jersey.

Society of Automotive Engineers, National Tractor Meeting—September 25 and 26, Schroeder Hotel, Milwaukee, Wisconsin.

National Lubricating Grease Institute, Ninth Annual Meeting—September 29 and 30, Stevens Hotel, Chicago, Illinois.

West Virginia Oil and Natural Gas Association, Annual Convention—October 2 and 3, Clarksburg, West Virginia.

National Safety Congress—October 6, 7, and 8, Stevens Hotel, Chicago, Illinois.

Texas Mid-Continent Oil and Gas Association, Annual Meeting—October 9, 10, and 11, Beaumont, Texas.

American Association of Petroleum Geologists—October 16 and 17, Los Angeles, California.

American Institute of Mining and Metallurgical Engineers, Petroleum Division—October 16, 17, and 18, Dallas, Texas.

National Stripper Well Association—October 20, Tulsa, Oklahoma.

Independent Petroleum Association of America, Twelfth Annual Meeting—October 20, 21, and 22, Tulsa, Oklahoma.

Society of Automotive Engineers, National Fuels and Lubricants Meeting—October 23 and 24, Mayo Hotel, Tulsa, Oklahoma.

American Institute of Mining and Metallurgical Engineers, Petroleum Division—October 29 and 30, Los Angeles, California.

California Natural Gasoline Association—October 31, Los Angeles.

American Petroleum Institute, 22nd Annual Meeting—November 3, 4, 5, 6, and 7, San Francisco, California.

New Mexico Oil and Gas Association—December 3, Artesia, N. M.

Oklahoma Stripper Well Association—December 5, Tulsa, Oklahoma.

American Institute of Electrical Engineers, Southeastern District—December 3, 4, and 5, New Orleans, Louisiana.

Society of Automotive Engineers, Annual Meeting (and Engineering Display)—January 12, 13, 14, 15, and 16, Book-Cadillac Hotel, Detroit, Michigan.

Texas Oil and Gas Association—February 28, 1942, Wichita Falls, Texas.

American Society of Mechanical Engineers, Spring Meeting—March 23, 24, and 25, 1942, Houston, Texas.

National Petroleum Association, Thirty-ninth Semi-Annual Meeting—April 16 and 17, Cleveland, Ohio.

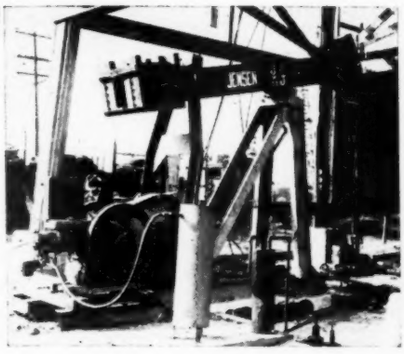
Petroleum Industry Electrical Association—April 22, 23, and 24, 1941, Shreveport, Louisiana.

American Association of Petroleum Geologists, Twenty-seventh Annual Meeting—April 21, 22, 23, and 24, Cosmopolitan Hotel, Denver, Colorado.

International Petroleum Exposition—May 16, 17, 18, 19, 20, 21, 22, and 23, 1942, Tulsa, Oklahoma.

American Society of Mechanical Engineers, Semi-Annual Meeting—June 8, 9, 10, and 11, 1942, Cleveland, Ohio.

American Society of Mechanical Engineers, Fall Meeting—October 12, 13, and 14, 1942, Rochester, New York.



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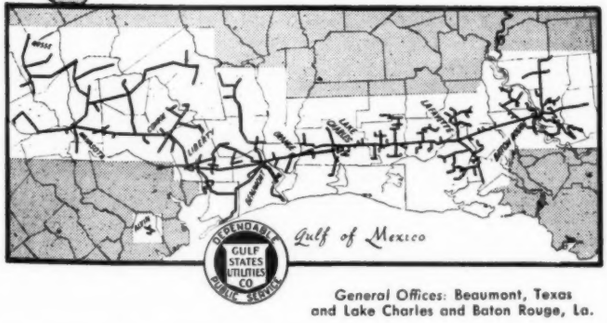

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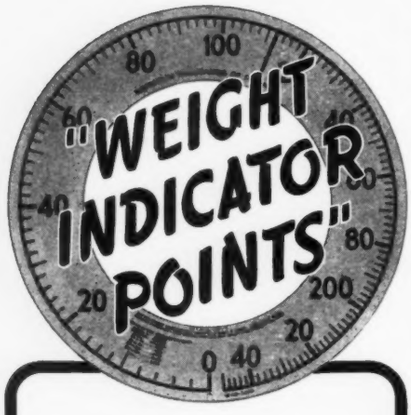

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